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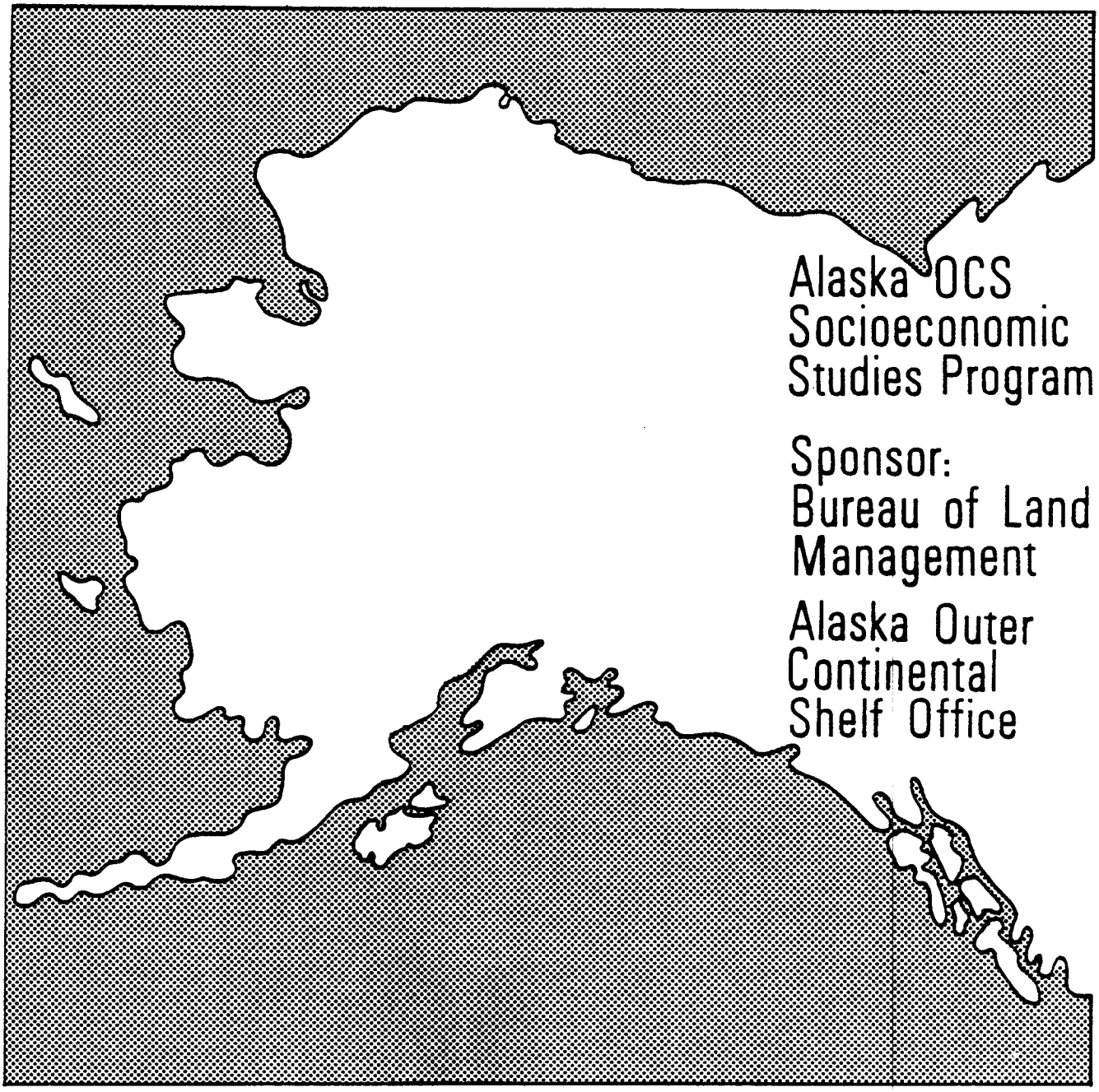

Alaska OCS
Socioeconomic
Studies Program

Sponsor:
Bureau of Land
Management

Alaska Outer
Continental
Shelf Office

BEAUFORT SEA TRANSPORTATION SYSTEMS ANALYSIS

The United States Department of the Interior was designated by the Outer Continental Shelf (OCS) Lands Act of 1953 to carry out the majority of the Act's provisions for administering the mineral leasing and development of offshore areas of the United States under federal jurisdiction. Within the Department, the Bureau of Land Management (BLM) has the responsibility to meet requirements of the National Environmental Policy Act of 1969 (NEPA) as well as other legislation and regulations dealing with the effects of offshore development. In Alaska, unique cultural differences and climatic conditions create a need for developing additional socioeconomic and environmental information to improve OCS decision making at all governmental levels. In fulfillment of its federal responsibilities and with an awareness of these additional information needs, the BLM has initiated several investigative programs, one of which is the Alaska OCS Socioeconomic Studies Program (SESP).

The Alaska OCS Socioeconomic Studies Program is a multi-year research effort which attempts to predict and evaluate the effects of Alaska OCS Petroleum Development upon the physical, social, and economic environments within the state. The overall methodology is divided into three broad research components. The first component identifies an alternative set of assumptions regarding the location, the nature, and the timing of future petroleum events and related activities. In this component, the program takes into account the particular needs of the petroleum industry and projects the human, technological, economic, and environmental offshore and onshore development requirements of the regional petroleum industry.

The second component focuses on data gathering that identifies those quantifiable and qualifiable facts by which OCS-induced changes can be assessed. The critical community and regional components are identified and evaluated. Current endogenous and exogenous sources of change and functional organization among different sectors of community and regional life are analyzed. Susceptible community relationships, values, activities, and processes also are included.

The third research component focuses on an evaluation of the changes that could occur due to the potential oil and gas development. Impact evaluation concentrates on an analysis of the impacts at the statewide, regional, and local level.

In general, program products are sequentially arranged in accordance with BLM's proposed OCS lease sale schedule, so that information is timely to decisionmaking. Reports are available through the National Technical Information Service, and the BLM has a limited number of copies available through the Alaska OCS Office. Inquiries for information should be directed to: Program Coordinator (COAR), Socioeconomic Studies Program, Alaska OCS Office, P. O. Box 1159, Anchorage, Alaska 99510.

TECHNICAL MEMORANDUM BF(71) - 6 CONTRACT NO. AA851-CTO-27

TRANSPORTATION BASELINE UPDATE AND FORECAST OF CONDITIONS WITHOUT THE PLANNED LEASE SALE, BEAUFORT SEA (71)

Prepared by

PETER EAKLAND AND ASSOCIATES

Prepared for

PEAT, MARWICK, MITCHELL & CO.

AND

BUREAU OF LAND MANAGEMENT

ALASKA OUTER CONTINENTAL SHELF OFFICE

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1.0 INTRODUCTION

The purpose of this working paper is to update the information on transportation systems contained in the environmental impact statement for the Joint Federal-State Beaufort Sea Lease Sale in 1979. Since that time, new issues have emerged and much new information has become available although the sale took place less than two years ago. Of particular concern are several potentially large-scale developments occurring both to the east and west of the first and proposed second Beaufort Sea outer continental shelf lease sales.

The up-dated information is intended to provide the Bureau of Land Management Outer Continental Shelf staff with base data to which transportation demands for Sale No. 71 can be added.

The report is divided into three main chapters. Chapter 2 describes existing conditions for the land, marine, and air modes. Chapter 3 contains a description and analysis of alternative routes for passenger and freight logistics and for the movement to market of oil and gas that is produced.

The primary study area is the Arctic Ocean coastline from Barrow east to the Canadian border. Because transportation systems serving the area originate beyond it, a large secondary study area is created which includes Arctic Canada and transportation links and terminals from Southcentral Alaska to the North Slope. Figure 1 shows the location of the first Federal/State Beaufort Sea lease sale area, the Arctic National Wildlife Refuge, National Petroleum Reserve - Alaska (NPR-A), and four categories of sites, including communities, DEW line installations, oil and gas production

enclaves, and proposed tanker port locatons. In several cases, sites fall into more than one of the categories.

A brief description of locations in Figure 1 follows:

North Slope Communities: Communities in the North Slope Borough include from west to east Pt. Hope, Pt. Lay, Wainwright, Barrow, Nuiqsut, and KaKtovik. Also shown on the map are Fairbanks and Umiat, which was the location of an NPR-A exploration well drilled by the Federal government and has a year-round airfield.

Oil and Gas Fields: Existing producing fields are at Prudhoe Bay and Kuparuk. An offshore lease sale in the Barrier Islands occurred in 1979. Exploration activities are underway, and there have been some gas discoveries. Additional State (offshore and onshore) and Federal (offshore) lease sales are scheduled in the Beaufort Sea over the next five years.

Oil and Gas Production Enclaves: Prudhoe Bay was the original year-round enclave established by oil and gas companies to provide services and facilities for its petroleum development activities in the nearby area. Kuparuk, which can be reached by road from Prudhoe Bay, in 1981 with the arrival of large modular buildings became the second enclave on the North Slope.

Potential Oil and Gas Tanker Terminals: Cape Thompson was considered in the NPR-A Section 105(b) report and Pt. Lay was examined as a potential port terminal site by the Federal-State

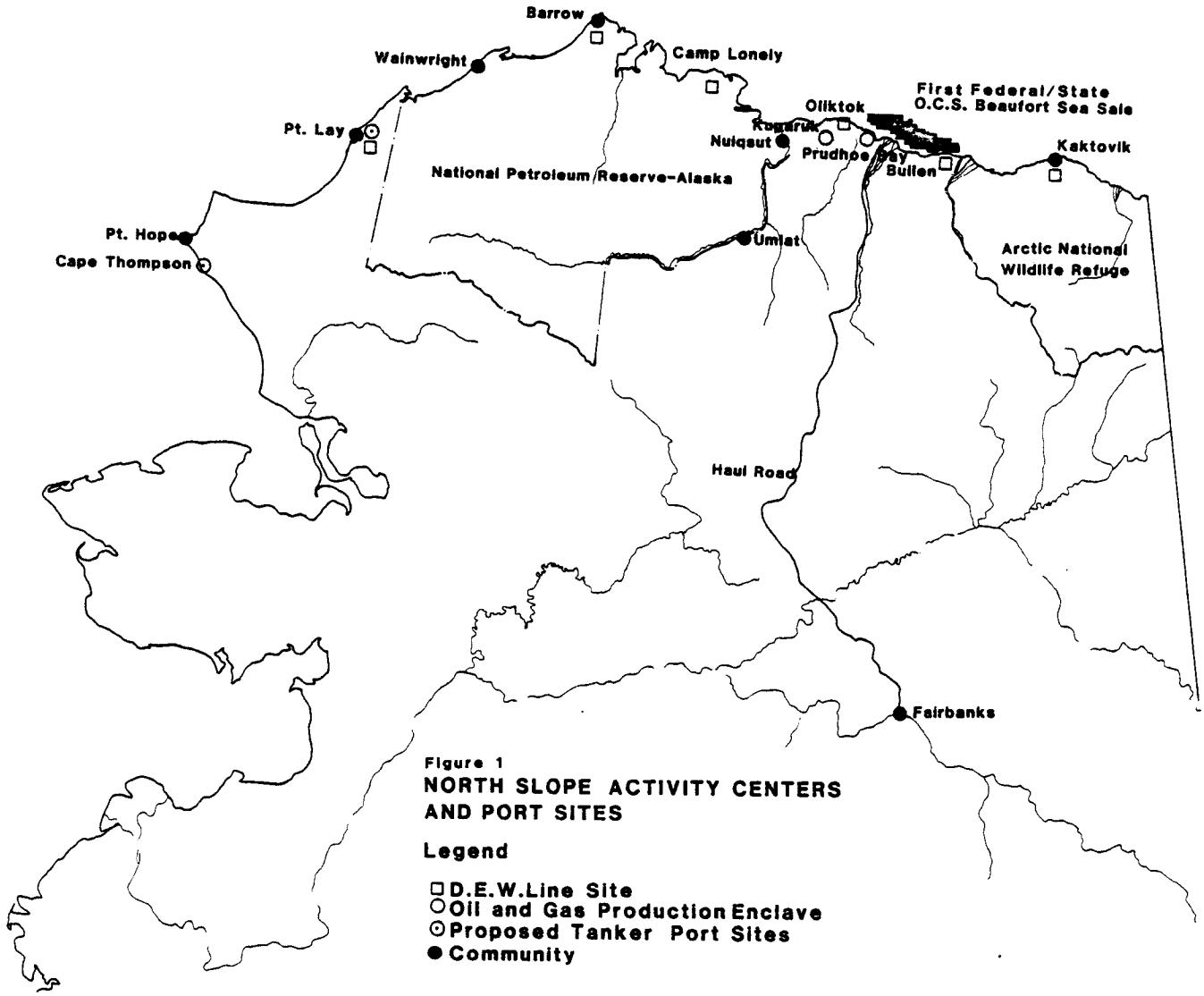


Figure 1
NORTH SLOPE ACTIVITY CENTERS
AND PORT SITES

Land Use Planning Commission (Engineering Computer Optecnomics, 1977). Shallow depths of the Alaskan Beaufort Sea make it unlikely that a land-connected pier, dock, or causeway structures can be provided for tankers. The only existing port facilities on the North Slope are the causeways at Prudhoe Bay. Barge landing locations include community and DEW line sites, which would have the advantage of an existing infrastructure ashore.

DEW Line Sites on the North Slope: Existing or former DEW line sites on the Beaufort Sea are logical locations to be used to support both offshore and onshore oil and gas activities. They have airstrips of varying length and condition, and the possibility exists of using covered storage areas. Existing installations are at Pt. Lay, Oliktok, Camp Lonely, Barow, and Kaktovik (Barter Island). Bullen Pt. is a former DEW-line site.

Camp Lonely was used extensively during pre-leasing exploration activities in NPR-A. Oliktok and Bullen (Flaxman Island) have not been used as yet to support oil and gas activities but are being considered as bases to support both offshore and onshore activties, but primarily the former. Oliktok would serve Kuparuk and possibly NPR-A, and Bullen would serve activities in the Pt. Thompson - Lisburne area.

2.0 EXISTING CONDITIONS

This chapter of the report describes the existing conditions of relevant transportation facilities and services by mode.

2.1 Highway Mode

2.1.1 FACILITIES

The major highway links over which freight destined for the North Slope is hauled are those leading to Fairbanks from Anchorage and Valdez and from Fairbanks north to Prudhoe Bay. All of the routes are on the Federal-aid system, which makes them eligible for Federal highway construction funds, and are maintained on a year-round basis by the Alaska Department of Transportation and Public Facilities. The Glenn/Parks Highway and Richardson/Alaska Highway routes are designated Federal primary roads and the Elliott Highway/Haul Road is a secondary Federal road.

Figure 2 shows the routes leading to Fairbanks and Figure 3 the roads north from Fairbanks. From Anchorage, the 358 mile (576 km) route to Fairbanks includes the Glenn HigHway to the Palmer area and then the Parks Highway. The route from Valdez to Fairbanks, which is only five miles (8 km) longer than the Anchorage route, is the Richardson Highway, which from Delta Junction to Fairbanks is also the last segment of the Alaska Highway. The route to Prudhoe Bay north from Fairbanks is the Elliott Highway for the first 74 miles (119 km). Near Livengood, the 416 mile (669 km) Haul Road begins. The first 56 miles (90 km) to the Yukon River Bridge have

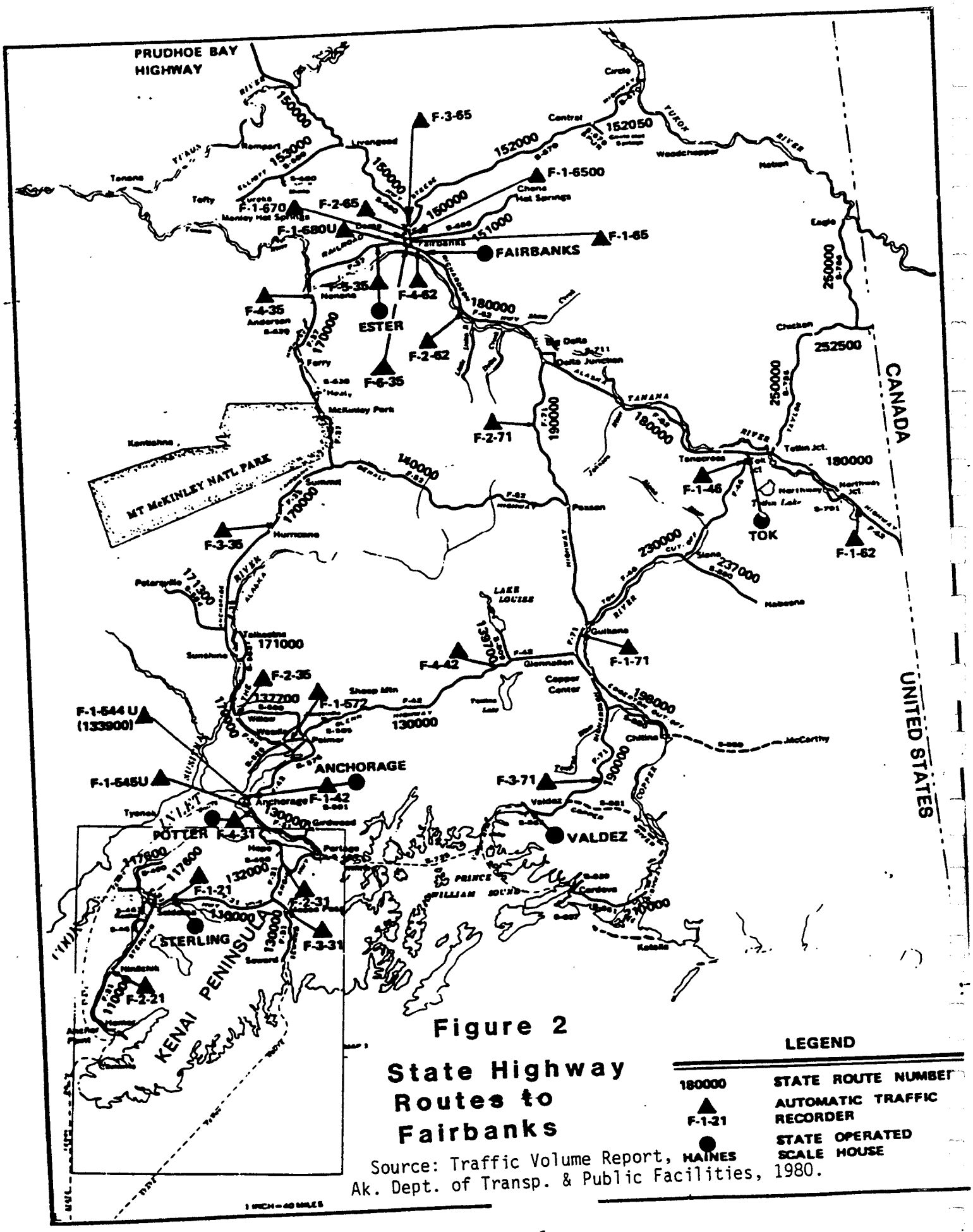
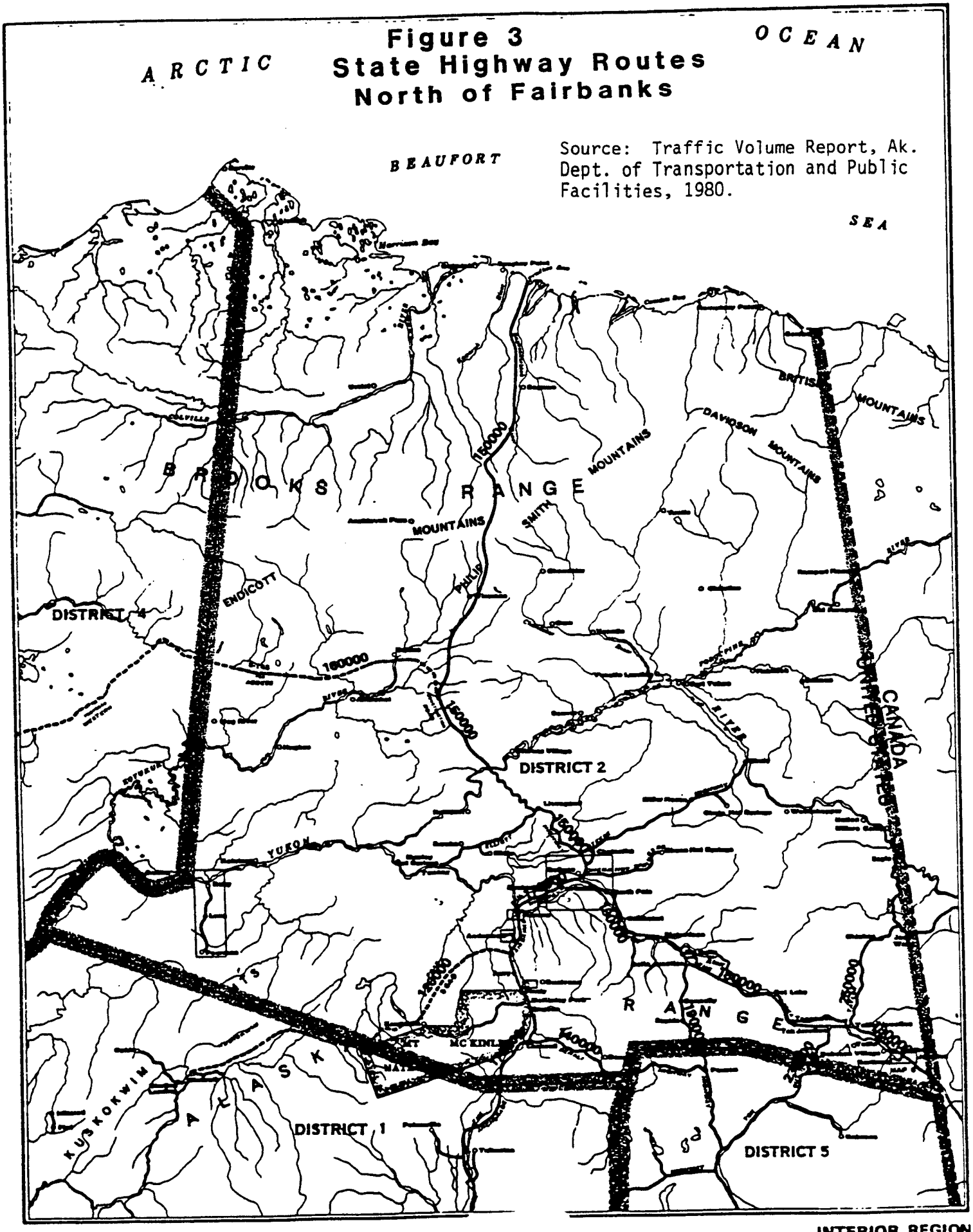


Figure 2

State Highway Routes to Fairbanks

Source: Traffic Volume Report, Ak. Dept. of Transp. & Public Facilities, 1980.

Figure 3
State Highway Routes
North of Fairbanks



Source: Traffic Volume Report, Ak. Dept. of Transportation and Public Facilities, 1980.

INTERIOR REGION

been open to the public since 1974. The remaining 360 miles (579 km) were accepted by the State from Alyeska Pipeline Service Co. in August, 1978. There was no public access for this section until June, 1981 when the road was opened as far north as Dietrich.

All mileage on the Richardson and Parks Highways are paved. The Elliott Highway is paved for the first 25 miles (40 km) out of Fairbanks and thereafter has a gravel surface. State of Alaska construction projects will extend the paved surface as far as Livengood within several years.

2.1.1.1 Richardson and Parks Highways

Table 1 contains data which indicates the overall status in 1979 of the paved routes that are under study in this report. Values based on a 0-100 scale are presented for road condition, traffic volumes (service), and accident rates. The values can be used to compare a given road section with other road sections in the State. For example, the "average" road section woud have a value of 50 in all categories. A condition value of 67 would mean that its condition was better than 67% of all paved mileage on the State road system. The composite value is based on the values for the three individual categories.

Data are shown for segments ranging from one to 29 (1.6 to 47 km) miles in length and are summarized for the major links. The data show that traffic volumes do not currently approach service capacities on any of the links. The only route segments having an average annual daily traffic (AADT) greater than 5,000 vehicles are the first seven miles (11.3 km) of the Parks Highway and the 20 miles (32 km) of the Alaska Highway south of Fairbanks. Except for the first 17 miles (27.4 km) of the Parks Highway,

Table 1. 1979 Status of Major Alaskan Highway Routes (1)

ROAD AND LINK		LENGTH (MILES)	AADT (2)	CONDITION VALUE	SERVICE VALUE	ACCIDENT VALUE	COMPOSITE VALUE
1. RICHARDSON HIGHWAY							
		10	4506	83	67	3	27
		12	1551	23	67	58	45
		9	370	66	86	29	55
		10	370	1	80	24	12
		9	370	26	86	52	49
		7	370	47	88	50	59
		13	370	44	88	35	51
		9	545	68	87	60	71
		7	598	78	84	66	75
		9	964	8	79	68	35
		11	1000	53	88	62	66
		5	1388	15	63	48	36
		8	1400	67	82	59	69
A. VALDEZ - GLENNALLEN	COMPOSITE	119	1078	44	81	46	49
	MINIMUM		370	1	63	3	12
	MAXIMUM		4506	83	88	68	75
		12	651	39	89	54	57
		3	610	55	84	47	60
		20	299	10	86	63	38
		6	285	9	89	68	38
		8	285	23	86	55	48
		23	277	27	88	58	52
B. GLENNALLEN - PAXSON	COMPOSITE	72	361	24	87	59	48
	MINIMUM		277	9	84	47	38
	MAXIMUM		651	55	89	68	60
		7	500	45	90	57	61
		10	461	30	86	65	55
		12	312	32	89	51	53
		16	313	47	90	49	59
		19	315	41	94	59	61
		9	352	32	95	56	55
		8	2045	34	69	72	55

Table 1 (Cont'd). 1979 Status of Major Alaskan Highway Routes[1]

ROAD AND LINK		LENGTH (MILES)	AADT[2]	CONDITION VALUE	SERVICE VALUE	ACCIDENT VALUE	COMPOSITE VALUE
C. PAXSON - DELTA JCT.	COMPOSITE	81	523	38	89	57	57
	MINIMUM		312	30	69	49	53
	MAXIMUM		2045	47	95	72	61
2. ALASKA HIGHWAY							
		10	1387	46	81	58	60
		9	1500	65	76	74	71
		14	840	33	85	77	60
		15	725	38	87	69	61
		9	759	54	87	68	68
		18	1767	69	77	74	73
		8	5679	74	87	61	73
		9	9648	46	82	74	65
		4	11135	49	79	55	60
A. DELTA JCT. - FAIRBANKS	COMPOSITE	96	2765	52	82	70	66
	MINIMUM		725	33	76	55	60
	MAXIMUM		11135	74	87	77	73
3. PRUDHOE BAY HIGHWAY							
		5	4399	63	90	45	63
		7	2596	71	74	31	55
A. FAIRBANKS - FOX	COMPOSITE	12	3347	68	81	37	58
	MINIMUM		2596	63	74	31	55
	MAXIMUM		4399	71	90	45	63
4. PARKS HIGHWAY							
		7	5436	70	45	59	57
		10	3654	61	52	55	56
		5	1700	60	67	55	61
		14	1580	82	68	58	69
		12	1055	75	82	11	41

Table 1 (Cont'd). 1979 Status of Major Alaskan Highway Routes(1)

ROAD AND LINK		LENGTH (MILES)	AADT (2)	CONDITION VALUE	SERVICE VALUE	ACCIDENT VALUE	COMPOSITE VALUE
		16	1055	69	79	67	71
		16	605	79	90	53	72
		18	480	69	93	65	74
		11	480	72	93	67	77
		20	480	58	90	66	70
		11	480	56	89	51	63
		11	480	57	92	56	66
		25	480	58	94	71	73
A. GLENN HWY. - DENALI HWY.	COMPOSITE	176	1082	66	83	58	67
	MINIMUM		480	56	45	11	41
	MAXIMUM		5436	82	94	71	77
		21	565	69	91	72	76
		18	539	53	87	78	71
		10	550	32	93	66	58
		17	550	63	93	78	77
		29	820	71	91	69	76
		24	809	59	89	68	71
		20	806	81	82	73	78
B. DENALI HWY. - ESTER	COMPOSITE	139	689	64	89	72	74
	MINIMUM		539	32	82	66	58
	MAXIMUM		820	81	93	78	78
		5	2362	20	1	60	11
		1	4090	67	60	72	66
C. ESTER - AIRPORT SPUR	COMPOSITE	6	2650	28	11	62	20
	MINIMUM		2362	20	1	60	11
	MAXIMUM		4090	67	60	72	66

Table 1 (Cont'd). 1979 Status of Major Alaskan Highway Routes

Notes: (1) Values in the table have been compiled from a condition survey report prepared by the Alaska Department of Transportation and Public Facilities. The composite rating shown in the last column is computed using ratings for condition, service, and accident. Low values indicate poor road characteristics. In order to intensify the effect of critical (low) values, the computation procedure used was to take the cube root of the product of the three individual values. The condition value combines data about ride, alligator cracking, full lane patching, and rutting into a single performance score which is converted into an overall condition value by a percentile ranking equation. To establish the service value, a ratio of the design hourly volume to the service capacity is firt computed. these results are then also converted into a percentile scale. The accident value is a percentile scale based on weighted accident rates for each road section.

(2) AADT = average annual daily traffic expressed in vehicles per day.

Source: "Paved highway performance evaluation," a computer listing prepared by the Alaska Department of Transportation and Public Facilities, 1980.

no service volume rating is less than 63. Only four segments have accident ratings less than 30. Three are on the Richardson and one on the Parks Highway.

The condition values vary widely between the routes analyzed. At least for the routes in question, condition problems are greater than those posed by traffic capacity and safety. Except for a short five-mile (8 km) segment between Ester and Fairbanks on the Parks Highway, no route segment on the Parks or Alaska Highways has a condition rating less than 30. However, on the Richardson Highway, four segments totaling 45 miles (72.4 km), have a rating of 10 or less and five more with an additional 58 miles (93.3 km) have a rating of 30 or less. The middle 72 miles (116 km) of the Richardson Highway between Glenallen and Paxson presently are in the worst condition of the major links, with a rating of 24. Next is the northern section from Paxson to Delta Junction with a 38 rating followed by the southern section from Valdez to Glenallen with a 44 rating. In contrast, the overall ratings for the two major sections of the Parks Highway are above 60. The poor condition of the Richardson Highway in large part is a legacy of the structural damage that occurred during construction of the Trans Alaska Pipeline. The road carried a large volume of truck traffic during that period, and much of this consisted of short trips for which enforcement of truck weight regulations was difficult.

Table 2 provides historical data for the average annual daily traffic and percentage of trucks and buses for the routes to Fairbanks from Valdez and Anchorage. The data come from permanent traffic recording locations maintained by the State of Alaska (See Figure 2). No station in 1978 had an average daily traffic figure greater than 1,000 except for the station two miles (3.2 km) outside of Fairbanks (F-4-62) and the one at Willow

Table 2. Historical Traffic Volumes at Selected Locations

Average Annual Daily Traffic[1]	Richardson Highway			Alaska Highway	
	F-3-71 (Rt. Mi. 66.7)	F-1-71 (Rt. Mi. 122.7)	F-2-71 (Rt. Mi. 223.6)	F-2-62 (Rt. Mi. 241.8)	F-4-62 (Rt. Mi. 293.4)
1970	164(L)	638	367	575	5647(L)
1973	213	521(L)	154(L)	451(L)	6693
1974	284	617	205	456	7783
1975	696(H)	999	552	643	10153
1976	562	1111(H)	697(H)	595	11266(H)
1977	367	651	312	699	11145
1978	275	543	207	730(H)	11022
1979	197	638	202	493	9944
30th Highest Hour for Year of Highest Traffic[2]	117(1975)	157(1976)	134(1976)	-	1261(1976)
% Trucks and Buses					
1975	-	22.7 %	31.2 %	20.8 %	3.7 %
1976	-	23.2 %	-	10.7 %	3.7 %
1977	17.7 %	10.1 %	18.7 %	7.1 %	4.7 %
1978	36.4 %	11.7 %	10.7 %	10.7 %	4.7 %
1979	16.5 %	9.3 %	26.4%	-	5.2 %

Notes: [1](H) = high value for data presented at each permanent counter location. (L) = low value for data presented at each permanent counter location.

[2] = The 30th highest hour is utilized by many states as a design criterion for rural highways.

Source: Alaska Department of Transportation and Public Facilities, Annual Traffic Volume Report, years 1975-1979.

Table 2 (Cont'd). Historical Traffic Volumes at Selected Locations

Average Annual Daily Traffic[1]	Prudhoe Bay Highway F-3-65 (Rt. Mi. 11.6)	Parks Highway F-2-35 (Rt. Mi. 36.0)	F-3-35 (Rt. Mi. 150.6)	F-4-35 (Rt. Mi. 268.9)	F-5-35 (Rt. Mi. 314.9)
1970	-	381(L)	-	-	364(L)
1973	-	737	334(L)	595(L)	637
1974	-	793	387	623	854
1975	-	943	516(H)	791	1136(H)
1976	-	1077	452	789	994
1977	-	1024	481	873	814
1978	-	1158	468	991(H)	820
1979	494	1248(H)	442	914	834
30th Highest Hour for Year of Highest Traffic[2]	-	283(1979)	91(1975)	129(1978)	119(1975)
% Trucks and Buses					
1975	-	11.7%	16.3 %	-	19.3 %
1976	-	9.6 %	12.0 %	14.2 %	12.2 %
1977	-	11.6 %	13.9 %	11.3 %	16.8 %
1978	-	12.7 %	16.3 %	14.2 %	10.6 %
1979	-	6.8 %	20.2 %	17.9 %	11.2 %

Notes: [1](H) = high value for data presented at each permanent counter location. (L) = low value for data presented at each permanent counter location.

[2] = The 30th highest hour is utilized by many states as a design criterion for rural highways.

Source: Alaska Department of Transportation and Public Facilities, Annual Traffic Volume Report, years 1975-1979.

(F-2-35) which experiences substantial recreational traffic during the summer. For the Richardson Highway, the highest traffic values at all stations were recorded in either 1975 or 1976. Truck traffic in excess of 20 percent also existed during this period on the road. At two of the stations, 1979 traffic figures were only about one-third of the high values.

On the Parks Highway, two of the stations recorded their highest annual traffic figures in 1975 but the other stations showed steady increases over the decade and recorded their high values in either 1978 or 1979.

2.1.1.2 North Slope Haul Road

The Haul Road was built by Alyeska Pipeline Company from 1973 to 1974 under the condition that the State would provide maintenance after completion of the pipeline. The road was designed to have a 28 foot (8.5 m) gravel travelling surface and was built within a 200 foot (61 m) right-of-way granted to the State of Alaska by the Department of the Interior. The Yukon River Bridge, constructed by the State of Alaska with $25.2 million of Federal Highway funds, was completed in 1975. For the year between completion of the road and completion of the bridge, an air-cushion barge was used to transport freight across the river.

The completion of the bridge produced a major shift in shipping patterns to the North Slope. As the only year-round surface route, the Haul Road became the primary route for freight movements. The State of Alaska accepted maintenance responsibilities for the road in October, 1978 although Alyeska had not brought the road up to secondary standards. The

two major discrepancies at that time were the absence of a six inch (15.2 cm) layer of surface coarse material and substandard bridges at Marion and Douglas Creeks. Alyeska agreed to stockpile material that could be used for the surface material and to help pay for replacement of the substandard bridges.

The state maintained the road with a combination of private contractors and its own crews until July 1, 1981. Since then, maintenance has been accomplished solely with State crews. From south to north, the maintenance stations are located at Yukon Crossing, Prospect, Coldfoot, Chandalar, Sagwon, and Deadhorse.

Truckers in 1980 voiced strong complaints about Haul Road conditions. They considered not driving the route because of high vehicle maintenance costs and unsafe driving conditions.

A study prepared for Atlantic Richfield Co. in 1980 examined separately the condition of the road surface and the bridges (Tetra Tech, 1980). Many of the road surface problems identified at that time related to the absence of adequate coarse materials. The fine materials had been blown away, leaving large rocks which are graded onto the shoulder. The average observed depth of fill during the ARCO study was four feet (1.2 m), which is the recommended standard for permafrost conditions; but it is slowly being depleted. The study also noted problems of soft shoulders, excessive dust, erosion, and inadequate enforcement of the 45 mph (72.4 km/hr) speed limit.

The study concluded that safety hazards existed at many bridges due to inadequate clearances and decking surfaces. The 24 foot (7.3 m) deck widths effectively provides only one lane of traffic unless speeds are low and the appoaches are properly delineated. One bridge which is scheduled

for replacement has only an 18 foot (5.5 m) width. Wooden deck planks are slick in wet weather. Numerous instances of protruding spikes create the danger of punctured tires.

A brief condition survey of the Haul Road conducted as part of the Western Alaska and Arctic Transportation Study (WAATS) classified sections as good, mostly good, or poor. The first 15 miles (24 km) north of the Atigun River were classified poor, the next 74 miles(119 km) "mostly good" and the remaining mileage good (Louis Berger, 1980).

Table 3 summarizes data for traffic crossing the Yukon River Bridge for the period 1976-1980. The highest monthly traffic figure was 465 vehicles and occurred in March, 1977. The traffic make-up was 58 percent trucks and 42 percent vehicles. Annual average daily traffic dropped substantially from 231 in 1977 to 99 and 71, respectively, in 1978 and 1979. The figure rebounded to 103 in 1980. With a decrease in traffic volumes, the standard deviation for monthly traffic has decreased and the percentage of trucks has increased. ARCO and SOHIO, the two unit operators at Prudoe Bay, between them accounted for aproximately 3,300 truck loads of northbound freight in 1980 and a two-fold increase is expected for the next few years.

Vehicle capacity of the Haul Road has been estimated at 175-550 passenger car units in both directions (Louis Berger, 1980). The actual figure at a given location and time depends upon the terrain, percentage of trucks, surface conditions, and weather. A 70 percent truck percentage by itself reduces capacity by 50 percent. Assuming worst conditions of the lower figure of the capacity range and a 50 percent reduction due to truck traffic, daily capacity would still be almost 600 vehicles, given a peak hour factor of 15 percent. Figures would be considerably higher for the

Table 3

Historical Summary of Haul Road Traffic

	Daily Vehicle Traffic				%
	Daily	Weekday	Saturday	Sunday	Trucks
(1)					
1976 Annual Average	266	276	263	218	45
Highest Monthly Avg.	381(Aug.)	395(Aug.)	374(Aug.)	316(Aug.)	67(Nov.)
Lowest Monthly Avg.	119(Dec.)	125(Dec.)	96(Dec.)	113(Dec.)	27(Sept.)
Monthly Avg. Standard Dev.	109	113	112	91	16
1977 Annual Average	231	239	208	216	38
Highest Monthly Avg.	465(Mar.)	467(Mar.)	436(Mar.)	481(Mar.)	58(Oct.)
Lowest Monthly Avg.	98(Jan.)	109(Jan.)	69(Jan.)	74(Jan.)	14(May)
Monthly Avg. Standard Dev.	115	113	124	123	14
1978 Annual Average	99	108	75	82	48
Highest Monthly Avg.	157(Jun.)	166(Jun.)	130(Jun.)	137(Jun.)	63(Nov.)
Lowest Montly Avg.	62(Oct.)	68(Oct.)	47(Oct.)	42(Oct.)	31(Jun.)
Monthly Avg. Standard Dev.	29	32	22	28	11
1979 Annual Average	71	74	70	57	59
Highest Monthly Avg.	89(Aug.)	93(Aug.)	89(Aug.)	77(Jul.)	71(Jan.)
Lowest Monthly Avg.	49(Feb.)	52(Feb.)	42(Feb.)	38(Feb-Mar)	48(Sept.)
Monthly Avg. Standard Dev.	11	11	14	12	6
1980 Annual Average	103	107	104	83	66
Highest Monthly Avg.	154(Aug.)	159(Aug.)	157(Aug.)	124(Aug.)	77(Dec.)
Lowest Monthly Avg.	68(Jan)	70(Jan.)	72(Jan.)	47(Feb.)	56(Sept.)
Monthly Avg. Standard Dev.	29	30	30	28	6

Notes: (1) Data available only for July-December.

Source: Interior Region Planning and Programming, Alaska Department of Transportation and Public Facilities.

level sections of the road.

The Bureau of Land Management has responsibility for issuing land use permits within the Utility Corridor. The corridor extends 336 miles (541 km) from Washington Creek south of Livengood to wihin 60 miles (96.6 km) of Prudhoe Bay. Its width is 12 to 24 miles (19.3 to 38.6 km). The Bureau of Land Management issued a land use plan for the corridor in March, 1981 based on three major decisions, as follows:

1. State highway needs for maintenance camps and material sites should be met in coordination with TAPS operation and maintenance, node development, and gas line construction.
2. Construction of the proposed Alaska natural gas pipeline has priority, but in close coordination with other corridor uses.
3. All permanent facilities except pump and compressor facilities should be consolidated at carefully selected nodes in the vicinities of Livengood Camp, Yukon Crossing-Five Mile Camp, Prospect, Coldfoot, Chandalar, and Pump Station #3. The latter two sites are located within the North Slope Borough.

The State of Alaska is responsible for establishing and enforcing management policies for traffic on the Haul Road. The general public must eventually be given access to the road since Federal funds were expended in its construction and that of the Yukon River Bridge. Governor Jay Hammond established an interim policy in 1978 limiting public access until after completion of the gas line. The anticipated date for opening of the road was 1983. A bill passed by the Alaska Legislature in 1980 and later upheld by the Alaska Superior Court resulting in the road being opened on June 1, 1981 as far north as Dietrich, which is located approximately halfway between Coldfoot and the North Slope Borough boundary.

At the present time, service facilities for the public exist only at Yukon Crossing. BLM did not generate any interest by private firms in establishing a new facility at Coldfoot.

2.1.1.3 Local Roads

Much of the truck traffic that carries freight to Prudhoe Bay originates in Fairbanks at the terminus of the Alaska Railroad. The remainder of the traffic travels by road from Anchorage and Valdez. Figure 4 shows designated truck routes in the Fairbanks area. The route out of Fairbanks to Prudhoe Bay is the Steese Highway, shown on the map at the upper right (northeast) corner of the map. The truck route by-passing Fairbanks to the south on Peger and Van Horn Roads is for traffic travelling to or from the Parks Highway and not stopping in Fairbanks. Traffic needing to go to the railroad yards takes the northern route consisting of segments of Phillips Field Road, Illinois Street, and College Road.

Complaints about truck traffic from Fairbanks residents during construction of TAPS resulted principally from truckers not using the designated routes. Local law enforcement is required to keep noise and traffic impacts to a minimum during high levels of construction activity.

2.1.2 CARRIERS

Numerous trucking companies carry freight to the North Slope via the Haul Road. Among the leading carriers of this traffic are K&W, Sourdough, Frontier, and Weaver Trucking. Oil companies spread the traffic around to encourage competition and to reduce the potential for delays should one

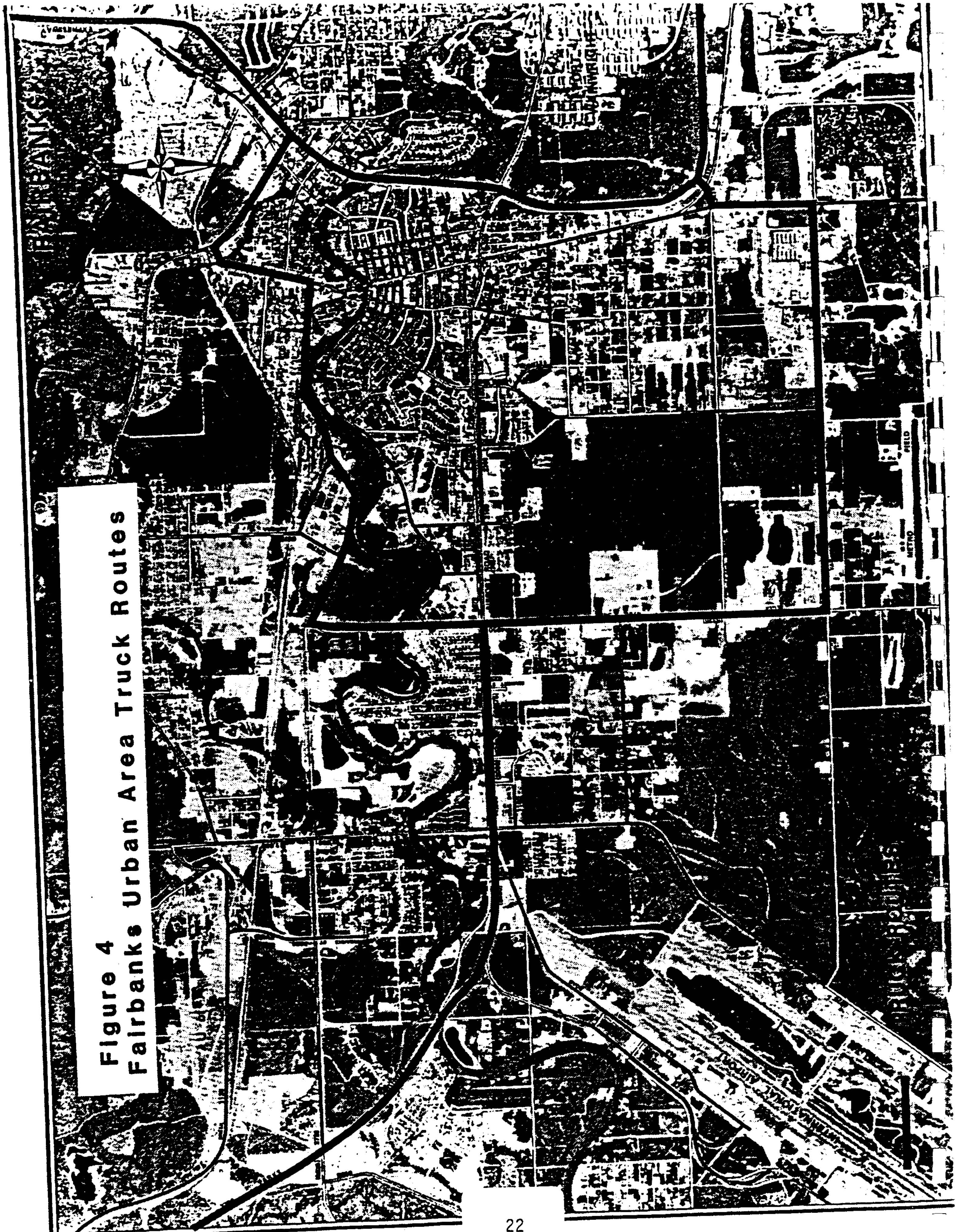


Figure 4
Fairbanks Urban Area Truck Routes

carrier experience financial or labor difficulties.

2.2 Marine

2.2.1 FACILITIES

Marine facilities appropriate for traffic to the North Slope are located at the four major ports of entry in Southcentral Alaska -- Anchorage, Seward, Whittier, and Valdez -- and docks constructed by the Atlantic Richfield Company at Prudhoe Bay.

2.2.1.1 Prudhoe Bay

Three facilities to unload barges exist at Prudhoe Bay, one at the East Dock and two at the West Dock. The average shipping season is six weeks from mid-August to late September.

The East Dock, constructed in 1969, is located in the southeast area of the Bay at the end of a 1,100 foot (335 m) gravel causeway having a width of 30 feet (9.1 m). Lighterage barges are grounded on a seasonal basis to provide a 100 foot by 270 foot (30.5 m by 82.3 m) wharf with a 4-1/2 foot (1.4 m) water depth. This dock is currently being used for loading onto shallow-draft barges gravel to be used in the construction of gravel islands.

The West Dock, located in the northwest area of the Bay has two loading facilities on its 40 foot by 10,100 foot (12.2 m by 3,078 m) gravel causeway. The one 4,500 feet (1,372 m) from shore was constructed in 1974 and has a draft of six feet (1.8 m). The causeway was extended an

additional 5,600 feet (1,707 m) in 1975 to facilitate unloading of ice-bound barges. The draft of the second facility is ten feet (3.0 m). As many as six barges can be unloaded at one time. Lightering is necessary for moving loads from a large barge until its draft can be accomodated at the dock. Barges used on the Mackenzie River can unload at the west docks without any load-lightening. These docks are curently being used for loading barges with gravel to be used in the construction of artificial isands. The water intake and treatment plant for the waterflood project will be located at the end of the causeway. As part of the project, the existing unloading area will be increased. Also, the causeway will be widened to permit two-way traffic of module-carrying crawlers.

Table 4 shows the number of barges and associated tonnage for Crowley Maritime sealifts from 1968 to 1981. The largest tonnage was the 1970 figure of 187,000 tons (169,643 metric tons) which was before completion of the Haul Road and at the start of Prudhoe Bay development activities. The 1981 sealift had the largest number of barges since I976.

2.2.1.2 Other North Slope Unloading Locations

No man-made structures to facilitate off-loading of supplies exist on the North Slope except at Prudhoe Bay, and no new facilities are currently proposed. Equipment needed to unload barges and ships is carried on the vessels. At locations where a barge can be beached close to shore, such as Lonely, a temporary ramp is used to assist in the unloading. Where deep-draft barges or long stretches of shallow water are involved, small vessels might be used to transfer the freght ashore. The North Star III carries four amphibious landing craft whih are used to carry both dry cargo

Table 4

Prudhoe Bay Sealift Traffic

Year	Tonnage (short tons)	Tugs	Barges
1968	7,000 (est.)	2	3
1969	75,000	16	32
1970	187,000	18	36
1971	16,000	3	6
1972	3,000	1	2
1973	21,000	4	8
1974	67,000	8	16
1975	153,000	24	48
1976	65,000	11	22
1977	46,000	4	7
1978	40,000	5	10
1979	10,000	1	2
1980	47,000	5	10
1981	70,000(est.)	7	14

Source: Crowley-Maritime, Seattle.

andbulk fuel ashore. Historic or proposed barge docking locations include include Peard Bay, which is midway between Wainwright and Barrow, Barrow, Camp Lonely, and Nuiqsut.

2.2.1.3 Port of Anchorage

The Port of Anchorage has four docks which serve as terminals for deep-draft ships. The dock face is dredged by the Corps of Engineers to a depth of -35 feet (-10.7 m) MLLW (mean lower low water). One of the terminals is used solely for petroleum deliveries. The other docks are used primarily for containerized freight but can also handle general cargo. The terminal closest to the petroleum terminal is an alternate petroleum unloading facility. Ships with ice-strengthened hulls call at the port throughout the year. Barge traffic is limited to months when Cook Inlet is free of ice, which is approximately mid-March to mid-November.

In May, 1981, the Port of Anchorage was initially selected to handle on a long-term basis large shipments of coal moving from the Usibelli mine in Healy to South Korea. However, further study determined that poor soil conditions and lack of available landside storage space made the Port an inappropriate location for this project.

Table 5 shows a breakdown of input and output tonnage at the Port of Anchorage in 1978. Of the two million tons (1.8 million metric tons) of the Port's throughput tonnage in that year, 52 percent was containerized. The remaining tonnage, in descending order, consisted of liquid bulk, dry bulk, and neobulk shipments. The containerized freight category includes container and trailer (roll-on, roll-off) shipments. A large imbalance

Table 5

Port of Anchorage
Summary of 1978 Waterborne Commerce
(Tons)

RECEIPTS

CARGO CATEGORY COMMODITY	FOREIGN	SOUTHERN CALIFORNIA	NORTHERN CALIFORNIA	PACIFIC NORTHWEST	COOK INLET	OTHER	TOTAL
CONTAINER							
Farm Products				30,630			30,630
Nonmetallic Minerals	624			14,533		223	15,380
Food Products				112,454			112,454
Wood Products				36,215			36,215
Furniture				10,255			10,255
Pulp & Paper	111			10,052		186	10,349
Chemicals & Allied Products	229	8,149		11,671		530	20,579
Petroleum Products				16,190		155	16,345
Primary Metal Products	14,260			21,962		430	36,652
Fabricated Metal Products	495			19,201			19,696
Machinery	6			12,656		22	12,684
Special Items	45			399,659		3,795	403,499
Other	2,394			14,954		50	17,398
Total	18,154	8,149		710,432		5,391	742,136
REEFER							
Food Products				70,922		225	71,147
Other	27			89		63	179
Total	27			71,011		288	71,326
NEO/BREAKBULK							
Lumber				57,186		8	57,194
Other				578		1,329	1,907
Total				57,764		1,337	59,101
DRY BULK							
Coal				15,492		12	15,504
Asphalt			25,610	20,310		21	45,941
Cement	11,968		1,826	106,685	2,946	61	123,486
Other				5,449			5,449
Total	11,968		27,436	147,936	2,946	94	190,380
LIQUID BULK							
Crude Petroleum	100,539						100,539
Fuels	365,234		128,838	7,557	194,379		696,058
Other	2			644			646
Total	465,775		128,838	8,201	194,379		797,243
MOTOR VEHICLES	2,368			19,739		91	22,498

SHIPMENTS

CARGO CATEGORY COMMODITY	PACIFIC NORTHWEST	KODIAK	ALEUTIANS	OTHER	TOTAL
CONTAINER					
Furniture	6,997	3,585			6,997
Primary Metal Products	5,913	181			6,913
Machinery	26,169				26,169
Misc. Manufactured Products	26,935	3,585	19	32	30,571
Special Items	26,926	181		5	27,112
Other	4,704	42		46	4,792
Total	98,644	3,808	19	83	102,554
REEFER					
Fish	11,189	142		159	11,490
Food Perishables	9,798	1,674			11,472
Total	20,987	1,816		159	22,962
NEO/BREAKBULK					
Scrap	9,530				9,530
Other	430				430
Total	9,960				9,960
DRY BULK					
Miscellaneous	260	111			371
LIQUID BULK					
Fuels	98		3,197		3,295
MOTOR VEHICLES	15,417			52	15,469

SOURCE: Waterborne Commerce of the United States,
U.S. Army Corps of Engineers

exists between inbound and outbound cargo. Inbound containerized cargo in 1978 was six times the figure for outbound tonnage (Alaska Consultants, Inc. and PRC Harris, Inc., 1981).

2.2.1.4 Whittier

The Port of Whittier, which is operated by the Alaska Railroad, receives rail-car barges and bulk fuel tankers at separate facilities. A 12.4 mile (20 km) rail line through two tunnels connects Whittier to the Seward-Anchorage mainline at Portage. Table 6 is a summary of inbound and outbound tonnage for the Port in 1978. The number of revenue railcars from 1972 to 1976 ranged from 8,000 to 10,000. Rail-barge service to Whittier is provided by Alaska Hydro-Train, a subsidiary of Crowley Maritime, from Seattle and from Prince Rupert, B.C. by Canadian National Railways. Two slips exist for the unloading of rail barges. The port is ice free but the area is subject to strong local winds, fog, and heavy precipitation. The port has limited area for expansion.

2.2.1.5 Seward

The Port of Seward, which is operated by the Alaska Railroad, was the principal port serving the Anchorage area prior to the 1964 earthquake but in 1978 handled only 97,000 throughput tons. A 200 foot by 735 foot (61 m by 224 m) concrete and steel finger pier provides two, 600 foot (183 m) deep-draft berths, each of which is served by a rail spur. Seward is connected to Anchorage by rail but the port does not have a rail-barge facility. Rail distance from Seward to Fairbanks is 470.3 miles (756.9 km).

Table 7

Port of Whittier
Summary of 1978 Waterborne Commerce
(Tons)

RECEIPTS (TONS)

CARGO CATEGORY COMMODITY	FOREIGN	PACIFIC NORTHWEST	BRITISH COLUMBIA	COOK INLET	TOTAL
CONTAINER					
Nonmetallic Minerals	500	602	3,129		4,231
Food Products	430	32,741	483		33,654
Wood Products	13	21,023	78		21,114
Pulp & Paper		9,116	76		9,192
Chemicals & Allied Products	45	7,807	1,694		9,546
Stone, Clay & Glass Products	3,657	1,409	373		5,439
Primary Metal Products	90	15,464	2,028		17,582
Fabricated Metal Products	144	7,370	181		7,695
Machinery	43	7,963	244		8,250
Special Items	41	9,468			9,509
Other	136	17,562	1,911		19,609
Total	5,099	130,525	10,197		145,821
REEFER					
Food Perishables	5	16,597			16,602
NEO/BREAKBULK					
Lumber	5,342	32,264	7		37,613
Other	1,711	471			2,182
Total	7,053	32,735	7		39,795
DRY BULK					
Sand & Gypsum		3,426	391		3,817
Cement		21,351	346		21,697
Other	265	1,962			2,227
Total	265	26,739	737		27,741
LIQUID BULK					
Fuels	1,492	1,330		8,429	11,251
Chemicals NEC	389	6,740	920		8,049
Total	1,881	8,070	920	8,429	19,300

SHIPMENT (TONS)

CARGO CATEGORY COMMODITY	FOREIGN	PACIFIC NORTHWEST	BRITISH COLUMBIA	PRINCE WM. SOUND	ALEUTIANS	TOTAL
CONTAINER						
Primary Metal Products		3,217				3,217
Fabricated Metal Products		3,872				3,872
Machinery	1,081	35,634	3,095			39,810
Special Items		9,781				9,781
Other		1,199				1,199
Total	1,081	53,703	3,095			57,879
REEFER						
Fish		1,192				1,192
Food Perishables		1,040				1,040
Total		2,232				2,232
NEO/BREAKBULK						
Lumber	3,244					3,244
Scrap	531	19,208				19,739
Total	3,775	19,208				22,983
LIQUID BULK						
Fuels				775	532	1,307
MOTOR VEHICLES	71	4,803				4,874

Source: Waterborne Commerce of the United States, U. S. Army Corps of Engineers

The port is being promoted as a site for exports of bulk goods. During the next ten years, major new marine facilities can be expected for the Seward area. The State of Alaska plans to build an $8.5 million grain storage and loading facility at the existing port area. Also, a private firm has entered into an agreement with the City of Seward to build a coal exporting facility. Finally, the city is plannig fr a $60 million marine complex in the Fourth of July Creek area which will consst of a dock, shipyard, ship fitting area, and marina. A 1,300 foot (396 m) dock will be able to service up to two deep-draft ships 600 feet (183 m) long at one time.

2.2.1.6 Valdez

The City of Valdez is constructing a modern single berth container terminal which will have a capacity of 550,000 tons (498,949 metric tons) and will handle dry goods exclusively. It is scheduled for completion in December, 1981. A separate facility exists for inbound and outbound refined petroleum products with a capacity from 794,800 to 1,656,000 tons (721,027 to 1,502,290 metric tons) per year. The Port of Valdez in 1978 had a throughput tonnage for dry cargo of less than 5,000 tons (4,536 metric tons).

The terminal facility handling exports of crude oil from TAPS has four deep-draft tanker loading piers. Reported water depths are 160 feet (48.8 m) for Berth No. 1 and 75 feet (22.9 m) for the other berths (No.'s 3,4,5). One report estimated that a fifth terminal would be needed as soon as daily throughput of the pipeline reached 1.6 million barrels (Dennis Dooley and

Associates, 1978). Based on figures in the Corps of Engineers' Deep-Draft Navigation Study for Southcentral Alaska, high and low annual capacity values for the existing berths are 145.1 and 123.2 million tons (131.6 and 111.8 million metric tons), respectively. These translate into daily throughput figures for the pipeline of 2.2 and 2.7 million barrels, respectively. Since both of these figures are above the capacity of the existing pipeline, a fifth terminal will not be needed until a parallel pipeline or loops in the pipeline are constructed.

2.2.2 CARRIERS

Until 1981, marine shippers to the North Slope have been limited almost exclusively to Crowley, which has operated the annual sealift to Prudhoe Bay for many years on a contract basis for oil companies; the North Star III, which is operated by the Bureau of Indian Affairs and serves native communities; the COOL Barge, an annual resupply operation for Federal activities, primarily those that are operated by the military, and finally Northern Transportation Co., Ltd., which is a Canadian Crown Corporation providing service to Canadian communities on the Mackenzie River and the Arctic Ocean. All of the above services are tug and barge operations with the exception of the North Star III.

Table 7 shows the locations on the North Slope that are served by the North Star III and the COOL Barge. Noe that operations of the latter service are more extensive than the former. For the four North Slope communtis, it is also interesting to note that the BIA vessel can get no closer to shore than one-half mile (0.8 km).

Table 7

North Slope Lcoations Served by Federal Marine Shipping Services

Location	North Star III[1]	North Star III Anchorage Distance from Shore (Nautical Miles)	COOL Barge[2]
Barrow	X	1.0 (1.9 km)	X
Point Lay	X	1.5 (2.8 km)	X
Point Hope	X	0.5 (0.9 km)	X
Waingwright	X	1.1 (2.0 km)	X
Barter Island (Kaktovik)			X
Cape Lisburne			X
Lonely			X
Oliktuk Point			X

Notes: 1. North Star III is operated by the Bureau of Indian Affairs.
2. The COOL Barge is the name of the annual military resupply to Alaska.

Source: Western and Arctic Transportation Study, Phase I, 1979. Prepare dby Louis Berger & Associates, Inc. for the Alaska Department of Transportation and Public Facilities.

The increasing amount of freight shipped to the North Slope in recent years and the prospect of a steady, long-term demand for marine shipping services to the area has prompted additional carriers to begin to compete for traffic. In 1981, three commercial carriers made trips to Barrow delivering supplies and fuel. They included Southeast Barge Lines, Arctic Pacific Lightering, and APUTCO (Alaska Puget United Transportation Companies), which is a subsidiary of Crowley Maritime Corporation.

Competition now also exists for shipments to Prudhoe Bay. Kodiak Marine Transport, which is a subsidiary of Nabors Drilling, took delivery in 1981 of new equipment designed for operations in heavy ice conditions. Its fleet of five barges and two tugs made its first sealift to Prudhoe Bay in September. Its cargo consisted of 500,000 gallons (1,892,700 liters) of fuel and miscellaneous construction equipment and supplies. The company hopes to be able to extend the shipping season by using a hovercraft pushed ahead of a tug to break ice and clear the way for vessels that are following. The hovercraft being considered is a 100 ton (91 metric ton) vessel owned by Veco/Global Marine.

For shipments into Southcentral ports, most tonnage arrives by either TOTE or SeaLand into Anchorage or by railbarge into Whittier. For the past few years, both TOTE and Sealand have offered twice-weekly service to Anchorage, TOTE with two vessels and SeaLand with three. The two carriers have split traffic evenly, SeaLand's advantage of frequency offset by TOTE's faster ships. SeaLand recently announced plans to add a fourth ship to its fleet.

2.3. Aviation

2.3.1. FACILITIES

The status of major and secondary airports on the North Slope will be examined as well as the internatinal airports at Anchorage and Fairbanks, which are the major origins and destinations, respectively, for flights to and from the North Slope. Tables 8-10 provide information on the major airports. Table 8 contains passenger and freight data by CAB certificated carrier for the following airports: Anchorage, Barrow, Deadhorse, and Fairbanks. Tables 9 and 10 contain information runway, ground facilities, and aids for navigation and landing. In the sections that follow, details about the various airports are presented.

2.3.1.1. Anchorage International Airport

From 1976 to 1979, aircraft operations at Anchorage International Airport declined about 17 percent from 249,000 to 207,000 (Alaska Department of Transportation and Public Facilities, 1980). The decline results from a substantial decrease in the number of local operations (from 82,000 in 1976 to about 33,000 in 1979) and reflects the increasing reluctance of small aircraft to compete for airway and runway space with large aircraft. Although local operations at the Anchorage facility declined from 1976 to 1979, both air carrier and military activity increased substantially. Air taxi and general aviation operations remained roughly the same.

Table 8
Traffic Data for Certificated Carriers - Calendar Year 1979

Airport	Enplaned Passengers (1)	Freight (Revenue Tons)	(Revenue Tons)	Departures Scheduled	Scheduled Departures Completed	Domestic Carriers Included
Anchorage (2)	906,704	111,896.08	25,594.32	17,445	93.82	Alaska, Flying Tiger, North-West, Reeve, Western, Wien
Barrow	22,611	279.18	399.62	667	84.78	Wien
Deadhorse	57,761	659.72	19.17	989	98.68	Wien
Fairbanks	219,322	3,628.58	4,034.14	6,733	95.30	Alaska, North-west, Wien

Notes: (1) Enplaned passengers are defined as boarding or departing passengers.
(2) Includes domestic and international traffic.

Source: Airport Activity Statistics of Certificated Route Air Carriers, Calendar Year 1979, U.S. Department of Transportation and Civil Aeronautics Board, Washington, D.C., 1980.

Table 9

Study Area Airports - Runways and Ground Facilities

Community	Location	Owner	Runway Heading	Length (ft)	Width (ft)	Surface Type	Heliport
Barrow	South side of surveyed townsite	State of Alaska	6-24	6,500	150	Asphalt	Yes
Deadhorse		State of Alaska	4-22	6,500	150	Asphalt	Yes
Kaktovik	North of town	Military	6-24	4,817	150	Gravel	No
Nuiqsut	East of town	Borough	NE/SW	2,500	50	Gravel	No

Table 9 (Continued)

Study Area Airports - Runways and Ground Facilities

Community	Navigation/Landing Aids[1]			
	Runway Heading	Lighting	Radio	Other
Barrow	-		VDR/DME, NDV,DF, ATCRBS	FSS, RCAG
	4		LOC,GS	
	4-22	MALSR,VASI		
Deadhorse	-		DF, VORTAC	FSS, RCAG
	6	MALS	GS, LOC/DME	MM
	24	REIL		
	6-24	VASI	NDB	
Kaktovik	-	REIL	NDB	RCAG, RCO-O

Note: 1. Lighting: MALSR = medium intensity approach lights with RAIL; VASI = visual approach slope indicator; MALS = medium intensity approach lights; REIL = runway end identification lights.

Radio: LOC = Localizer; GS = glide slope; VDR/DME = distance measuring equipment; NDB = nondirectional beacon; DF = direction finder; ATCRBS = air traffic control radio beacon system; VORTAC = combined VOR & TACAN.

Other: FSS = flight service station; RCAG = remote center air ground facility; MM = middle marker; RCO-O = remote communications outlet.

Sources: FAA, 1980; DOTPF, 1981; North Slope Borough, 1981.

Table 10

Study Area Airports - Operations and Aids

Community	Service Level [1]	Design Type [2]	Total 1979 Operations	Based Aircraft (1979)	Scheduled Airlines	Based Air Taxis [3]
Barrow	AC	AC	14,000	12	1	2 FW
Deadhorse	AC	AC	15,000	15	1	5 FW, 1 R
Kaktovik	AC	AC	NA	3	1	1 FW
Nuiqsut	GA	BU	NA	0	0	0

Community	Terminal Building	Hangars	Fuel	Maintenance
Barrow	Yes	Yes	No [4]	Yes
Deadhorse	Yes	Yes	Yes	Yes
Kaktovik	Yes [5]	Yes [5]	Yes [5]	Yes [5]
Nuiqsut	No	No	No	No

Table 10 (Continued)

Notes: (1) Service Level

AC = Air Carrier (Certificated Service)

GA = General Aviation

(2) Design Type

AC = Air Carrier (Certificated Service)

BU = Basic Utility

(3) FW = Fixed Wind; RW = Rotary Wind.

(4) Fuel services at Barrow Airport are privately owned and not for public use.

(5) Terminal, building, hangars, and fuel are government owned and not available to the general public although the terminal can be used for shelter while waiting for aircraft. The strip is maintained by the military.

Sources: FAA, 1980; DOTPF, 1981; North Slope Borough, 1981.

With the opening of the new north-south runway in 1980, Anchorage International has four asphalt runways, three exceeding 10,000 feet (3,048 m) in length. According to the most recent Master Plan, the facility is currently operating at about 50 percent of capacity. On the basis of current projections and anticipated aircraft operating characteristics, capacity will not be reached until after the year 2000. Similarly, the construction of a new international terminal will provide sufficient additional space at the existing facility to accomodate growth in domestic traffic for the foreseeable future.

During 1979, enplaned (boarding) passengers totaled 1,118,400, of which CAB certificated carriers accounted for about 81 percent. The number of enplaning passengers increased about 17 percent between 1976 and 1979, a growth rate that is higher than that of the Municipality of Anchorage's population during the same period.

The facility also serves an important role in freight transportation to and within Alaska. In 1979, throughput tonnage at the airport amounted to 127,239 tons (115,428 metric tons) which was about seven percent greater than the 1976 throughput of 118,821 tons (107,792 metric tons). Transshipment by Wien, and to a lesser extent by Northern Air Cargo and Alaska International Air, of goods arriving in Anchorage by the water mode to remote Alaskan communities accounts for outbound cargo (77,833 tons, or 70,608 metric tons, in 1979) being about 60 percent greater than inbound cargo (49,405 tons, or 44,819 metric tons) at the airport.

2.3.1.2 Fairbanks International Airport

The State owned and operated Fairbanks airport has two parallel

runways, 10,300 feet by 150 feet (3,139 m by 45.7 m) and 3,200 feet by 60 feet(975 m by 18.3 m). The 1980 Master Plan estimates that using current forecasts, the facility will reach about 60 percent capacity in the year 2000 (Rafson, 1981). No new runway construction is planned over the next 20 years, although the Master Plan does propose construction of a 40,000 square foot (3,716 sq. m) terminal expansion beginning in 1983 to accomodate forecast growth in international operations.

Total operations in FY1979 were 146,827, of which certificated air carriers represented about 12 percent, air taxis about four percent and general aviation (including local operations) about 75 percent. The high percentage of general aviation operations at Fairbanks as compared to Anchorage (40 percent) reflects the existence at Anchorage of a number of alternative facilities catering to local and general aviation.

During FY1979, enplaned passengers at Fairbanks totaled 242,783. More than 90 percent of these departed Fairbanks on CAB certificated air carriers. Unlike Anchorage where outbound passengers outnumber those inbound, inbound and outbound passengers at Fairbanks are about equal. Throughput cargo tonnage in FY1979 amounted to 66,652 tons (60,465 metric tons). The disparity between inbound and outbound cargo is even more pronounced at Fairbanks than at Anchorage. In 1979, the transshipment by air of cargo arriving in Fairbanks by truck or rail to remote communities accounted for outbound cargo (48,796 tons, or 44,267 metric tons) being more than double inbound cargo (17,856 tons, or 16,199 metric tons).

2.3.1.3. Barrow

Airport facilities at Barrow have been considerably upgraded in the

past several years. A 9,000 square foot (836 sq. m) terminal constructed by Wien in late 1979 incorporates a passenger ticketing and holding area as well as a restaurant, gift shop, and restrooms. A freight handling facility is housed separately. The terminal operation also includes fuel tanks with a storage capacity of 50,000 gallons (189,270 liters). Fuel is available for Wien aircraft only. The North Slope Borough 1980 Capital Improvemnt Program includes funding for the construction of a hangar for two search and rescue helicopters and a small aircraft; however, no site has been identified for the facility and no firm construction date has been set

The asphalt runway at Barrow measures 6,500 feet by 150 feet (1,981 m by 45.7 m). The airport is equipped with a full range of navigation aids and has an FAA flight service station. The Barrow airport serves the community of Barrow. A gravel strip at the Navy Arctic Research Laboratory provides logistical support for the Laboratory and the nearby DEW Line Station. However, this facility is scheduled to be abandoned when the laboratory closes in 1981.

Data collected by the FAA indicate that in FY1979 there were 14,000 operations at the Barrow airport, including 2,000 air carrier and 8,000 air taxi operations. This is an increase of 75 percent over the number of operations in FY1976.

Two air taxis operate out of Barrow. Cape Smythe Airways provides service to other North Slope communities primarily with a Twin Otter and is the current Wien subcontractor for carrying passengers, mail, and freight. Jen-Air provides charter service within the region with smaller aircraft.

In the winter of 1980-1981, Wien provided once weekly combined passenger and freight service to Barrow from Anchorage and eight flights

weekly from Fairbanks wih a B-737. By September, 1981, trhe frequencies of both services had increased substantially. Anchorage-Barrow service became daily, ad Fairbanks-Barrow service became 11 flghts per week. Alaska International Air, Inc. provides scheduled freight service to Barrow from Fairbanks five days per week with a Hercules. In 1979, Wien enplaned 22,600 passengers at Barrow and handled approximately 280 revenue tons (254 metric tons) of freight and 400 revenue tons (363 metric tons) of mail at Barrow. According to the CAB, about 85 percent of the airport's scheduled departures are completed.

2.3.1.4. Deadhorse

The Prudhoe Bay/Deadhorse area is served by two airports. A private strip at Prudhoe Bay is maintained by Atlantic Richfield Co. and can accomodate Hercules-type aircraft. The State-operated Deadhorse airport has a 6,500 foot by 150 foot (1,981 m by 45.7 m) asphalt runway, is equipped with a full range of navigation aids, and has an FAA flight service station. The 15,800 square foot (1,468 sq. m) Wien terminal at this airstrip includes a passenger holding and ticketing area, restrooms, and warm storage. Wien operates its own fueling facility. Alaska Airlines began construction of a 24,000 sq. ft. (2,230 sq. m) terminal facility which will contain areas for cargo storage and handling, passengers, office space, and employee housing and dining.

FAA data indicate that in FY1979 Deadhorse had a total of 15,000 operations, roughly the same as in 1976 which was at the height of oilfield development and pipeline construction activity. In the winter of 1981, Wien provided scheduled passenger and freight service to Deadhorse from

both Anchorage (four flights per week) and Fairbanks (19 flights per week), while Alaska International Air provided freight service four times per week from Anchorage via Fairbanks. The frequency of passenger service from Anchorage to DFeadhorse increased substatially in 1981. In 1980, Wien enplaned about 58,000 passengers and 680 revenue tons (617 metric tons) of freight and mail at the Deadhorse Airport. CAB data indicate that 98 percent of the airport's scheduled departures are completed.

Although there are no accurate data on the level of charter activity at Deadhorse it is substantial. Atlantic Richfield and Sohio operate twice daily passenger charters from Wien and Alaska Airlines, respectively, using either B-727 or B-737 aircraft. Four air carriers, Audi Enterprises, Evergreen and Era Helicopter and Alaska Iternational Air, Inc. have charter operations based at Deadhorse. Audi Enterprises serves primarily the village of Kaktovik, while Evergreen and Era support oilfield operations at Prudhoe Bay and the surrounding area. AIA provides support for both the Prudhoe Bay operators and NPR-A out of Deadhorse. In 1980, Alaska International Air alone shipped about 14 million tons (12.7 metric tons) from Deadhorse.

2.3.1.5. Kaktovik

The community of Kaktovik has a 4,817 foot by 150 foot (146.8 m by 45.7 m) gravel strip used jointly by the village and the nearby Barter Island DEW Line Station. The facility is owned and operated by the military. Navigation aids include a remote center air ground facility, nondirectional radio beacon and runway and identification lights. Although none now exists, the North Slope Borough plans to construct a small

terminal and apron at the Kaktovik Airport. Scheduled service to the community is available from Fairbanks and Barrow. Arctic Circle Air, under subcontract to Wien, provides twice weekly service from Fairbanks and Cape Smythe Flying service provides once weekly Twin Otter service from Barrow via Deadhorse.

2.3.1.6 Nuiqsut

Nuiqsut has a 2,500 foot by 50 foot (762 m by 15.2 m) gravel strip which because of poor drainage is inoperable during break-up. In the spring of 1981, the North Slope Borough will embark upon a major upgrading of the facility. Planned improvements include a new 5,000 foot by 150 foot (1,524 m by 45.7 m) gravel runway, a 50 foot by 575 foot (15.2 m by 175.3 m) taxiway, a 200 foot by 300 foot (61 m by 91.4 m) apron and a 3,280 square foot (304.7 sq. m) terminal which will incorporate both cold and warm storage, a waiting room and office. The project will also provide runway lighting and a rotating beacon. The only scheduled service to Nuiqsut is provided by Cape Smythe twice weekly from Barrow. Once upgraded, the airfield will be capable of handing C-130 cargo planes.

2.3.1.7. Camp Lonely

The runway at Camp Lonely, which is the site of a DEW line installation, was upgraded by the U.S.G.S. during exploation drilling of NPR-A and now has a length of 5,200 feet and a width of 103 feet (1,585 m by 31.4 m). It is capable of handling C-130 cargo planes year-round. Extensions were also made to the apron and taxiways. All facilities used

for supporting drilling operations were turned over to the military, and any potential user for upcoming oil and gas activities would have to obtain a lease from the Air Force. Facilities at the airfield include a cargo building(40 feet by 100 feet, or 12.2 m by 30.5 m), a hangar, and a weather shack/control tower. The following navigation and landing aids are in place: rotating beacon, apron lights, runway marker lights, strobe lights, visual approach slope indicator, nondirecional radio beacon, and marker lights. The facility can be used with complete safety on a year-round basis by a wide range of aircraft types.

2.3.2. CARRIERS

The Alaska Transportation Commission (ATC) regulates all common air carriers operating within the State of Alaska and with the Civil Aeronautics Board (CAB) jointly regulates those carrirs that operate intrastate routes. The ATC issues permits in three categories: air taxi operators, scheduled carriers, and contract carriers. Scheduled carriers currently operate only fixed-wing aircraft, while both rotary and fixed-wing aircraft are available from contract and air taxi operators.

2.3.2.1. Air Taxi Operators

Air taxi carriers offer their services to the general public from one or more fixed bases of operation specfied in their operating certificate. Most operate aircraft with certified gross take-off weights less than 12,500 pounds; however, the ATC has authority to grant air taxi certificates to operators having larger aircraft. The only carrier with

such authority in the study area has a Deadhorse base. Aircraft approaching a weight of 12,500 pounds (5,670 kg) are the Twin Otter, the Trislander, and the Lear Jet, which each have seating capacities as high as 17 persons.

The other major division is between fixed-wing and rotary-wing (helicopter) operations. Table 11 shows he breakdown of air taxi operators by operating base within the prime study area. In some cases, the same operator has rights in the area for both fixed-wing and rotary-wing operators. Operators must provide "safe, adequate, efficient, and continuous service from and maintain bases of operation at listed locations (in their certifications)" as required by the Alaska Transportation Commission.

Air taxi operators specialize in serving remote locations inaccessible by highway. Typically, air taxi operators receive subcontracts from larger carriers for mail routes. In the primary study area, Cape Smythe provides mail service to Wainwreight, Nuiqsut, Atkasook and Point Lay while Arctic Circle Air provides mail service to Kaktovik (Barte Island). Passenger flights serve established villages as well as recreation and mineral exploration sites.

2.3.2.2. Contract Carriers

Contract carriers generally are not restricted by location in their operating authorities. Principal contract carriers within the State of Alaska include Northern Air Cargo, Inc., Munz Northern Airlines, Inc., and Alaska International Air, Inc. (AIA). Both AIA and Northern Air Cargo are currently involved in service on the North Slope. Scheduled carriers also

Table 11

Study Area Air Taxi Operators

Number of Operations

Base of Operations	Fixed Wing		Rotary Wing		Operators
	Less Than 12,000 lbs	More Than 12,000 lbs	Less Than 12,000 lbs	More Than 12,000 lbs	
Barrow	2				Jen-Air, Cape Smyth
Colville Delta	1				Arctic Tern
Deadhorse	4	1	3		AIA, Era, Sea Airmotive Gay, Audi
Kaktovik	1				Audi
Sagwon		1			AIA
Umiat	1				Umiat Ent.

Source: Alaska Transportation Commission, 1981.

Table 12

Alaska International Air, Inc. (AIA) Shipments to Selected North Slope Locations - 1980
(Pounds)

Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total
NPR-A	17,119,500	6,205,000	1,046,000	2,147,000	26,517,500
Villages[1]	3,574,500	7,072,000	13,103,500	8,216,000	31,966,000
Beaufort Sites	1,337,000	4,143,500	170,000	655,000	6,305,500
Chukchi	2,394,000	2,596,000	4,263,000	10,000	9,263,000
Deadhorse	313,000	132,000	1,615,000	1,994,600	4,054,600
TOTAL	24,738,000	20,148,500	20,197,500	13,022,600	78,106,600

Note: (1) Includes Barrow, Kaktavik, Nuiqsut, Atkasuk, Wainwright and Pt. Lay.

Source: Alaska Transportation Commission, Quarterly Reports of Carrier Operating Activity.

have the right to engage in contract operations where the origin is on a scheduled route. Alaska Airlines operates a twice daily 727 service from Anchorage to Deadhorse for Sohio. Wien's service on the same route for Atlantic Richfield technically is not a charter since passenger seats are purchased at the regular tariff and cargo space is available to all shippers.

AIA is the most prominent contract carrier in the study area. The company has a fleet of five Hercules cargo planes, eqch with a maximum capacity of from 45,000 to 48,000 pounds (20,412 kg to 21,773 kg). Although AIA operates worldwide, all five aircaft are generally maintained in Alaska. During periods of intense actrivity, as many as four of the aircraft may be in service on the North Slope. In 1980, the company's North Slope activity was about equally divided between the villages (North Slope Borough) and petroleum exploration and development sites, primarily within NPR-A. Although the company's maintenance facilities are in Fairbanks, a mechanic has been based at Lonely during the recent period of extensive drilling activity in NPR-A. Table 12 shows a breakdown of shipments made in 1980 by North Slope destination and quarter.

2.3.2.3. Scheduled Carriers

The Alaska Transportation Commission has only one category of scheduled carrier, but the CAB makes a distinction between major trunk airlines and commuter services. Commuter services are considered by the latter agency to fly aircraft with gross weights less than 12,500 pounds (5,670 kg), and trunk airlines are those that offer flights greater than 500 miles (805 km), usually with jet aircraft.

Table 13 shows the level of services provided between the communities of Barrow, Deadhorse, Anchorage, and Fairbanks and major cities. Table 14 shows the time and cost characteristics of services shown in Table 13.

• Trunk Airlines

Only one trunk airline, Wien Air Alaska, currently operates service to the study area; however, Alaska Airlines was granted authority to serve Deadhorse from Anchorage and Fairbanks in 1980 and will begin this service in December, 1981. As almost all traffic to Deadhorse and, to a lesser extent, Barrow has an origin or destination outside the region or the State, carriers providing connecting service with Fairbanks and Anchorage are impacted by development activity in the study area. Trunk airlines providing such service are Alaska Airlines, Wien, Northwest Orient, Western Airlines, and Flying Tiger (cargo only).

- Wien Air Alaska. Wien currently operates B-737 jet aircraft in either the all-passenger and mixed passenger-cargo modes depending upon traffic demand. Deadhorse and Barrow flights originate in both Anchorage and Fairbanks; however, most service to both these points originates in Fairbanks, primarily because a major portion of the traffic flies from Anchorage to Deadhorse on charter aircraft. Wien's 1980-1981 scheduled winter service to the North Slope included one flight per week from Anchorage to Barrow, eight flights per week from Fairbanks to Barrow, four flights weekly from Anchorage to Deadhrose, and 19 flights weekly from Fairbanks to Deadhorse. Service is expanded considerably during the summer, primarily to accomodate tourist demand. The carrier operates 27

Table 13

Passenger Service Provided by Scheduled Carriers

Scheduled Carrier	Route	Minimum Required Service(1)	Summer 1980 Service	Winter 1981 Service
Alaska	Anchorage-Fairbanks		42 flts./wk.	32 flts./wk.
	Anchorage-Seattle	--	42 flts./wk.	21 flts./wk.
	Fairbanks - Seattle		7 flts./wk.	5 flts./wk.
Northwest	Anchorage-Seattle	--	14 flts./wk.	14 flts./wk.
	Anchorage-Chicago	--	5 flts./wk.	2 flts./wk.
	Fairbanks-Seattle	--	7 flts./wk.	4 flts./wk.
Western	Anchorage-Seattle	--	35 flts./wk.	28 flts./wk.
Wien	Anchorage-Seattle	--	14 flts./wk.	21 flts./wk.
	Anchorage-Fairbanks	--	28 flts./wk.	27 flts./wk.
	Anchorage-Barrow	--	--	1 flt./wk.
	Anchorage-Deadhorse	--	10 flts./wk.	4 flts./wk.
	Fairbanks-Barrow	14 flts./wk. peak; 7 flts./wk. off-peak	14 flts./wk.	8 flts./wk.
	Fairbanks- Deadhorse	7 flts./wk. peak and off-peak	19 flts/wk.	19 flts./wk.

Note: (1) Essential air service as determined by the Civil Aeronautics Board.

Source: Carriers' schedules.

Table 14

Service Characteristics for Scheduled Passenger Service to North Slope and Points Outside the Region

Link	Carrier	Statute Miles	One-Way Coach Fare	Cost ¢/mile	Elapsed Time
Seattle-Anchorage	Alaska	1,709	$204.18	11.9	3:05
Seattle-Fairbanks	Northwest	1,533	$209.21	13.6	3.05
Chicago-Anchorage	Northwest	2,839	$350.11	12.3	5:35
Anchorage-Fairbanks	Wien	261	$ 79.80	30.6	0:55
Fairbanks-Barrow	Wien	503	$177.05	35.2	1:25
Fairbanks-Deadhorse	Wien	377	$105.00	27.8	1:05
Anchorage-Barrow	Wien	725	$178.50	24.6	1:50
Anchorage-Deadhorse	Wien	631	$168.00	26.6	1:40

Sources: Airline Tariff Schedules and Tariffs, 1981; Civil Aeronautics Board Miles Table, August 1980.

flights weekly from Anchorage to Fairbanks.

Prior to 1979, Wien offered service only within Alaska, with the exception of service to Whitehorse in the Yukon Territory. In that year, Wien received authority to provide service from Anchorage to Seattle directly as a result of the CAB's West Coast Service Investigation. In the winter of 1980-1981, Wien operated 21 nonstop Anchorage to Seattle flights weekly. The CAB has also granted Wien permission to operate from Anchorage to Chicago, but the carrier has not yet exercised the authority. As of September, 1981, Wien also began flights from Anchorage to Boise and Salt Lake City via Seattle.

- Alaska Airlines. Alaska will initiate service to Deadhorse in December, 1980. The carrier concentrates on routes linking Anchoorage and Seattle (21 flights per week in the winter of 1981 and 42 flights per week in the summer of 1980). However, it also serves Fairbanks nonstop from Seattle five days per week and from Anchorage with 32 flights per week in the winter and 42 flights per week in the summer. Service is primarily provided with B-727 aircraft, but the B-737 recently has been added to the airline's fleet.

- Northwest Orient. Aside from Alaska Airlines, Northwest is the only carrier that provides direct Fairbanks to Seattle service. Its DC-10 service is operated five days per week during the winter and daily in the summer months. From Anchorage, Northwest provides direct service to both Seattle and Chicago. The Seattle service operates twice daily with a DC-10, while the Chicago flight, also a DC-10, runs twice weekly during the winter and five times per week during the summer.

The company plays a significant role in air freight movements to Anchorage with its triangular freight-only service between Seattle, Anchorage, and Tokyo using a B-747 freighter. In the winter of 1981, the route was operated only in a clockwise direction with Anchorage added as an intermediate stop on the westbound leg of the Seattle-Tokyo service. The Anchorage stop permits a higher load factor on the westbound leg. Frequency is three times weekly. In the summer of 1981, the company will increase frequency to four times per week and hopes to make a stop in Anchorage on the eastbound leg at least once or twice a week. In calendar year 1979, Northwest Orient's freight operations delivered 8,444 revenue tons (7,660 metric tons) to Anchorage International Airport.

- Western Airlines. In the winter of 1980-1981, Western offered four 727 flights daily and one DC-10 flight daily to Seattle from Anchorage. An additional daily DC-10 flight is added during the summer months.

- Flying Tiger Airlines. In Janmuary 1977, Flying Tiger initiated all-cargo flights to Anchorage. As with the Northwest cargo service, Anchorage is an intermediate stop between flights from the Lower 48 (primarily New York, Chicago, Los Angeles, and San Francisco) and the Orient. Flights average three daily on the eastbound leg and two daily on the westbound leg. Almost all flights use the B-747, although an occasional DC-6 is used. The bulk of the freight carried is inbound except during the summer when fish is flown both to the Orient and the Lower 48. In calendar year 1979, Flying Tiger's throughput at Anchorage was 84,052 revenue tons (76,250 metric tons), well over half the total throughput of the certificated air carriers in that year (137,492 revenue tons, or 124,730 metric tons) and more than double the throughput of any other

certificated carrier at the airport.

- Commuter Airlines.

At the present time, there is no commuter service on the North Slope. Sea Airmotive, Inc. is certificated by the ATC to provide such service between Deadhorse, Nuiqsut, and Barrow, and has excercised this authority several times since 1976. The company has been issued a temporary suspension by the ATC through January, 1982.

2.3.2.4. Rotary (Helicopter) Carriers

Rotary wing aircraft have been used extensively on the North Slope by companies engaged in resource exploration and development because they permit quick access to remote areas by personnel and equipment without the need to construct airstrips. Three rotary wing carriers -- Era, Sea Airmotive, and Gay -- are certificated by the ATC to operate at Deadhorse. All three are limited to operating equipment with gross take-off weights less than 12,500 pounds (5,670 kg). Other carriers are able to provide servicves on a contract basis. Helicopter operations at Deadhorse have increased with more exploration activities at locations that cannot be reached by road. They are used to transfer employees to and from work sites and also to carry light cargo. Carriers specializing in North Slope work have established maintenance facilites at Deadhorse and base aircraft there according to the demand, which varies from season to season. Equipment can be quickly moved to other areas of the State if necessary.

3.3.3 REGULATIONS

Four Federal and State agencies have primary responsibility for regulating air carriers and air transportation facilities in the State of Alaska. These include the Civil Aeronautic Board, an independent Federal regulatory agency; the Federal Aviation Administration located within the U.S. Department of Transportation; the Alaska Department of Transportation and Public Facilities, and the Alaska Transportation Commission.

The Federal Aviation Administration(FAA) is charged with regulating air commerce to foster aviation safety. The FAA's air safety responsibilities extend to aircraft, airmen, airports, and navigational facilities. FAA issues and enforces rules, regulations, and minimum standards for the manufacture, operation, and maintenance of aircraft. It also rates and certifies the technical proficiency and medical fitness of airmen, certifies the technical proficiency and medical fitness of airmen, certifies airports serving air carriers with CAB certificates, and flight inspects air navigational facilities. FAA is responsible for installing and operating visual and electronic aids to navigation that promote safe and efficient utilization of the naviagable airspace. Activities include operation of airport traffic control towers and flight service stations. There are presently no control towers on the North Slope, but there are full-time flight service stations at Barrow and Deadhorse. In addition, the FAA provides a large percentage of funds used in Alaska to upgrade runways and landing aids at airports. Grants can be provided to either the State of Alaskaor local governments, depending upon ownership of an airport.

The State of Alaska Department of Transportation and Public Facilities has jurisdiction over many of the State's airports. Within the study area, the State of Alaska owns and operates the Barrow and Deadhorse airports, while the North Slope Borough owns the Nuiqsut facility and the military has jurisdiction over the Kaktovik and Camp Lonely facilities.

Airline fares and routes fall under the jurisdiction of the Civil Aeronautics Board for interstate carriers and of the Alaska Transportation Commission for intrastate carriers. As part of the Airline Deregulation Act of 1978, the Board was required to determine a minimum level of essential service for each certificated point receiving service from one or more certificated carriers. In Alaska, there was a special provision for a service level equal to that of 1976 or two round trips per week, whichever is greater. Fo Barrow, this was determined to be 14 fights per week freom Fairbanks during the peak season and seven flights per week during the off-peak season. Minimum service required to Deadhorse from Fairbanks was determined to be seven flights per week during the peak and off-peak seasons.

For planning purposes, the CAB recognizes Anchorage, Fairbanks, and Juneau as the State's transportation hubs. At the next level of importance are twelve regional centers, of which Barrow is one. Interstate air freight transportation has been completely deregulated by the CAB. Deregulation of interstate air passenger transportation is proceeding on a five-year timetable.

The ATC issues operating authorities for three separate categories of intrastate carriers, as follows: air taxi operator, scheduled carrier, and contract carrier. Certificates of public convenience and necessity are required for carriers operating aircraft with maximum payload capacities in

eexcess of 7,500 pounds (3,402 kg) or having a maximum seating configuration inn excess of 30 passengers. Carriers with small aircraft desiring opperating authority as either scheduled air taxis or contract operators are reequired only to show that they are "fit, willing, and able to provide the puublic with safe, efficient, ;and continuous air service." Criteria in eestablishing these qualifications under 1980 legislative changes include tthe financial, management, and equipment capabilities of the applicant. In acddition, the proposed service must be found to be not contrary to the puublic interest. The burden of proof is on a person opposing issuance of tthe certificate. For many areas of the State, air taxis have served the saame function as scheduled carriers where distances are short and schedules aire infrequent. The new legislation recognizes the similar characteristics of travel by small aircraft. A likely result will be that many air taxis will seek scheduled carrier status on routes that have adequate demand to support them.

Scheduled carriers, as defined by Alaska statutes, provide air commerce to the public on a regular basis and collect remuneration based primarily on individual fares or a per-pound basis for freight. The operating authority for scheduled carriers specifies the routes to be served, the type of aircraft to be used, and the frequency of service to be provided. Scheduled carriers may provide contract and charter services to or from any point on a route authorized to be served by the carrier.

Air taxi operators provide aircraft to te general public on a charter or contract basis from a specified base or bases of operation. Such operators may establish additional bases if they are judged to be fit, willing, and able. Air taxi operators no longer are restricted to operations within an identified area of the State. Contract carriers are

private for-hire carriers who operate under contracts of a continuing nature or perform specialized services.

Any limitations in service imposed on air carriers by the ATC are included as part of each operating authority. The ATC maintains a close working relationship with the Civil Aeronautics Board, which regulates all carriers certified for interstate movement of passengers and freight. Alaska is the only state where by law an official relationship exists between a state agency regulating air transportation and the Civil Aeronautics Board. All carriers applying to the CAB for certification as an exempt carrier, which entitles it to carry mail, must first have an air taxi certificate from th ATC.

With deregulation of the air carrier industry by the CAB, ATC's influence may be limited to smaller markets than previously, since carriers for larger markets can more easily receive certification from the CAB than in the past. As stated in a recent order (80-4-28), "We (the CAB) conclude that the Airline Deregulation Act and our procompetitive policies compel us to apply the presumption in favor of applications for route authority in Alaska just as we do in the lower 48."

Before July 1, 1980, one of ATC's purposes was to provide for the competition necessary to assure development of an air transportation system adapted to and adequate to meet th needs of the commerce of the state. This section was repealed and replaced by provision for "fair and equitable competition through qualified operators who are fit, willing, and able to serve thepublic with safe, efficient, and continuous air service." Deregulation activities of the CAB may have contributed to this change, but other changes indicate deregulation within Alaska appears to be limited to smaller aircraft.

3.0 ALTERNATIVE ROUTINGS

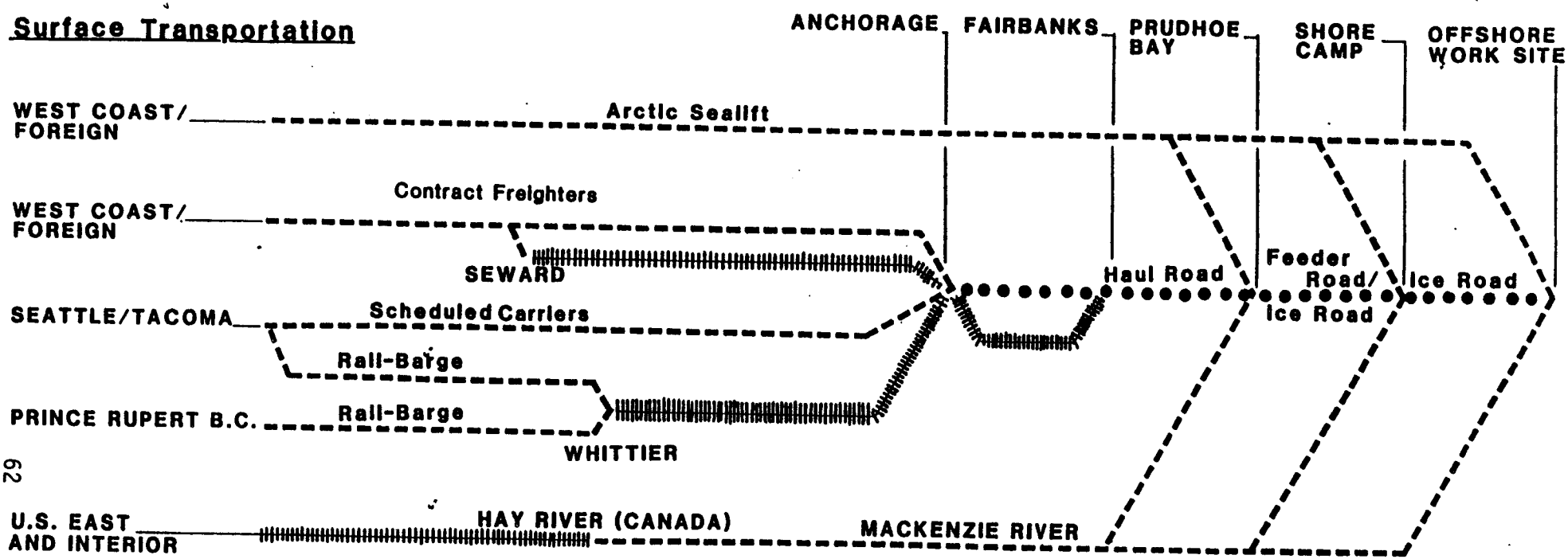
Figures 5 to 7, respectively, show the alternative routings for inbound logistics, North Slope oil, and North Slope gas.

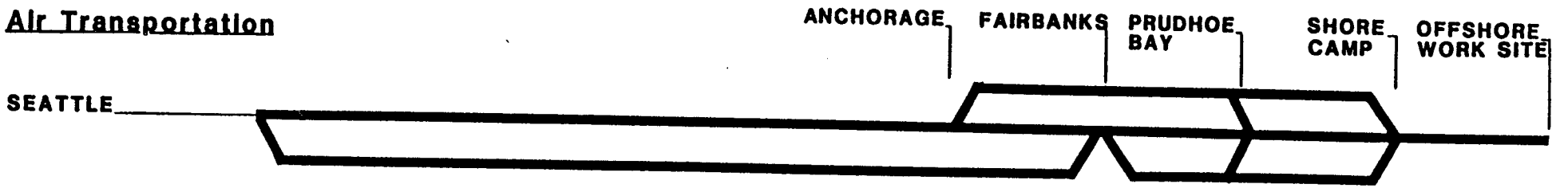
The ultimate choice of transportation routes for the movement of goods, resources, and passengers to and from the North Slope depends upon decision-making by both governments and shippers. Transportation associated with the exploration, development, and production of petroleum reserves provides striking examples of the processes involved. Governments, through laws and regulations, establish constraints under which oil and gas companies must make decisions governing the choice and utilization of routes. The extent of these constraints varies from the actual choice of competing routes to limitations on how a route can be constructed. The permitting process for pipelines is an example of the government role in the selection of routes. Another example is the requirement that oil carried through TAPS cannot be exported. The use of overland routes in the Arctic is subject to seasonal constraints and approval of designs and construction methods for permanent roads. Environmental, political, and social factors all enter into the governmental decision-making process that establishes the extent of constraints to be imposed.

The other level of decision-making involves the selection of routes by shippers given constraints established by government agencies. Factors affecting this choice are speed, reliability, cost, availability (seasonal or year-round), location of origin and destination, type of materials being shipped, and availability of proven technologies. Included among costs of

Figure 5

INBOUND LOGISTICS ROUTES FOR NORTH SLOPE OIL AND GAS ACTIVITIES





Legend

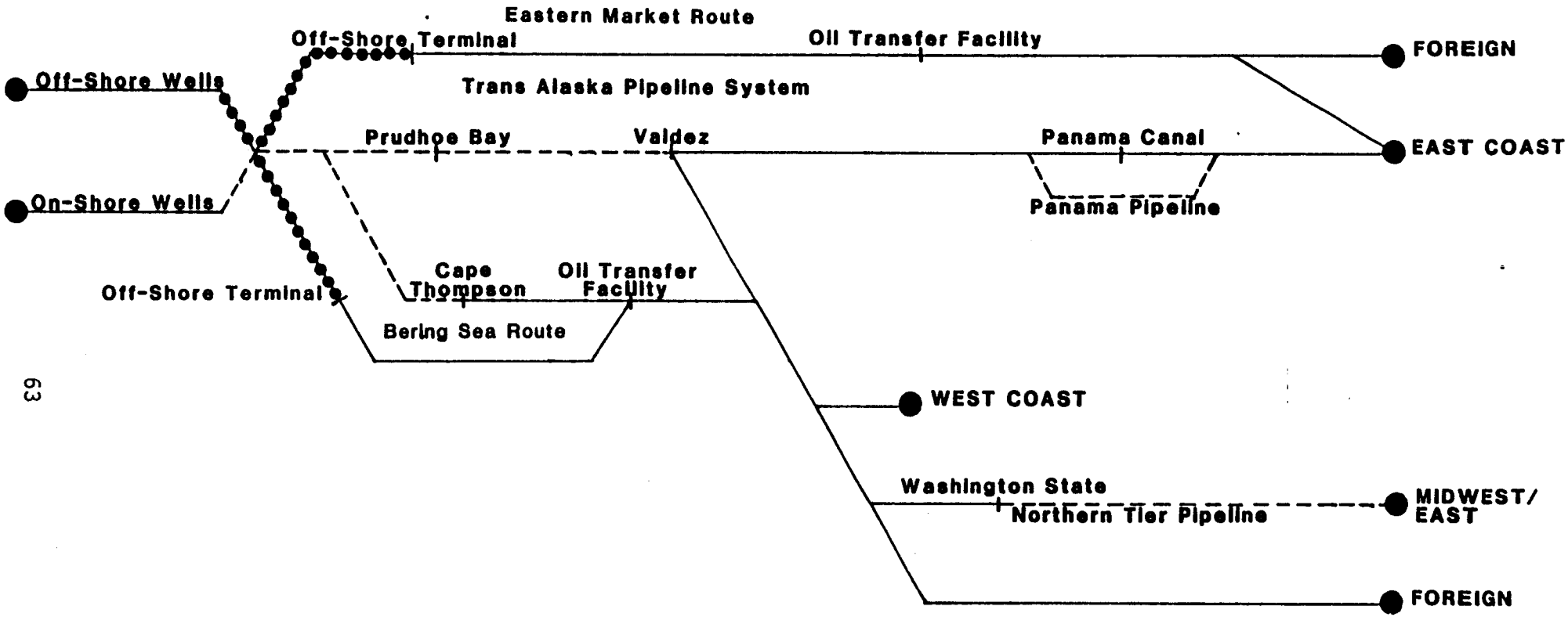
Road ●●●●● Water - - - - -

Railroad ||||||||||| Air ▬▬▬

Source: Peter Eakland and Associates

Figure 6

ROUTES FOR THE MOVEMENT TO MARKET OF NORTH SLOPE OIL



Legend

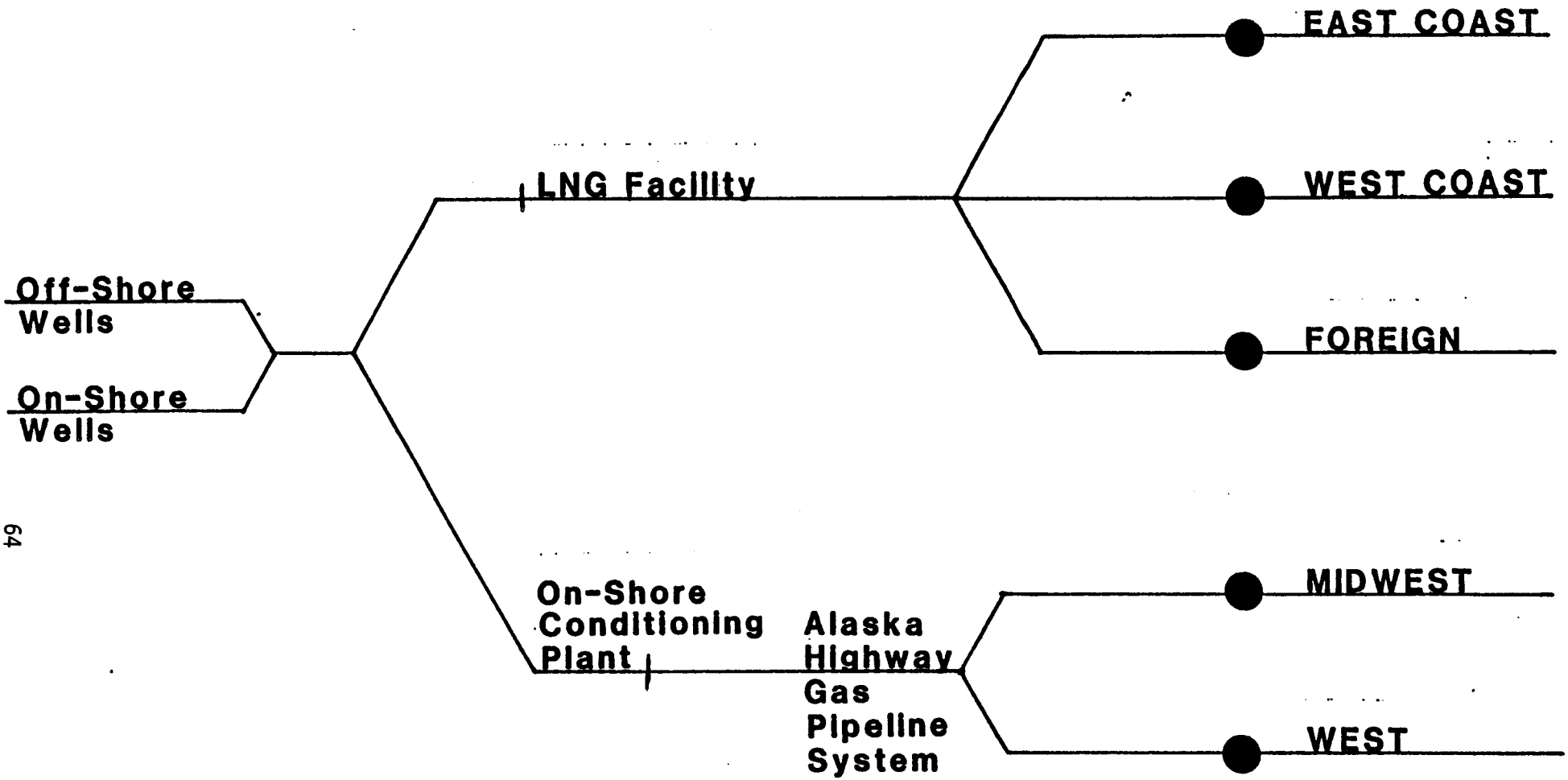
Land Pipeline ----

Water Pipeline •••••

Source: Peter Eakland and Associates

Figure 7

ROUTES FOR THE MOVEMENT TO MARKET OF NORTH SLOPE GAS



Source: Peter Eakland and Associates

freight are those from the time of purchase to actual use. These include the following:

- preparation of goods for shipment.
- inventory costs at origin, destination, and intermediate locations.
- handling costs.
- average costs of damage and loss.
- inspection costs.

3.1 Inbound Logistics Routes

The use of a given mode of travel to and from the Arctic regions of Alaska may change dramatically from season to season and between phases of an activity. The air mode will be vital during the exploration phase of activities at isolated sites. The implementation of a year-round land route requires a long lead time and has high costs of construction. The marine mode can be used only during the short summer shipping windows. Land routes first become important during development unless a site can easily be connected to an existing road system, as was the case with the Kuparuk Field.

Three basic routes, as shown on Figure 5, exist for shipping goods to the North Slope. The all-marine route is the Arctic sealift which originates in Seattle. The Alaska land route has an initial marine link with origins on the west coast of the United States or Canada. The third route is the Mackenzie River.

3.1.1. Mackenzie River

The Mackenzie River route first involves shipping via rail to Hay River on the Great Slave Lake. From there, tug and barges travel 1,074 miles (1,728 km) on the Mackenzie River to the Beaufort Sea. At the mouth of the river, navigable conditions generally exist from July to late September. The Northern Transportation Co., Ltd. (NTRCL) is a Canadian Crown corporation that transports general cargo to settlements on the river and to coastal communities in the western Arctic region of Canada.

Several private Canadian companies have undertaken small operations to exclusively serve oil and gas exploration activities in the Beaufort Sea and the Mackenzie Delta. The barges operating on the river have drafts of five to six feet (1.5 to 1.8 m) and can carry loads as great as 1,340 tons (1,216 metric tons).

NTCL has transported cargo to Prudhoe Bay since 1963. The level of traffic there decreased substantially when the Haul Road opened in 1976 and now is only two or three tug trips per year. One tug can haul up to three barges. NTCL barges can reach the West Dock facilities at Prudhoe Bay when fully loaded. Most of the current tonnage is drill casing originating in the east or Houston but drilling muds are also carried. Tariffs are competititve with the Haul Road route, but the Mackenzie route does not offer the same flexibility. Present use of the route varies from company to company. SOHIO ships very little tonnage via the Mackenzie at the present time but ARCO estimates approximately 15 percent of its North Slope tonnage goes by this route. Despite low utilization of this route by Alaskan oil and gas activities, the oil companies recognize that the

Mackenzie River is an important alternate route to the Haul Road.

3.1.2. ARCTIC SEALIFT

The Arctic Sealift is operated annually by Crowley Maritime and utilizes ocean-going barges 100 feet wide by 400 feet long (30.5 m by 121.9 m). One tug generally hauls two barges. Oil companies depend upon the sealift for the transportation to the North Slope of over-sized modules and large equipment that cannot be moved by other means. Pipe and other bulk cargo is also carried as space permits. However, in the absence of the need to transport large modules, companies would not use the sealift.

Major increases in sealift operations will occur for the next three years (1982-1984) due to the development of the Kuparuk Field, but tonnages probably will never again approach the size of the record 1970 sealift.

3.1.3 SOUTHCENTRAL ENTRY PORTS AND HAUL ROAD

Shippers try to minimize the number of intermodal transfers in choosing routes. Goods reaching the west coast by rail generally will be shipped by rail barge to Whittier and from there by rail to Fairbanks. Trucks will then carry the freight the remaining distance. For containerized freight, shippers almost exclusively use the Port of Anchorage. From the Seattle-Portland area there are four sailings per week to Anchorage, two by Sea-Land and two by TOTE. Shipment of drilling supplies by the Haul Road rather than by the seasonal water routes substantially reduces inventory costs at Prudhoe Bay.

The three primary carriers to Anchorage -- TOTE, Sea-Land, and

Hydro-Train -- never have large differentials in their tariffs despite differences in the type of services offered. Cheapest tariffs at the present time are those of Canadian National Railways which has rail-barge service from Prince Rupert, but it also has low capacity.

Once the cargo reaches Anchorage, flexibility exists as to the choice of the next mode. Valdez even with its new containerized terminal and virtually the same driving distance to Fairbanks as from Anchorage will not be able to overcome Anchorage's present advantages.

Early in the development of Prudhoe Bay, approximately 80 percent of LTL (less than truckload) tonnage was carried by air. Now this percentage is carried on the Haul Road and the remaining 20 percent goes by air (Edmunds, 1981).

Greatest use of the land route to Prudhoe Bay from the Southcentral ports occurs in the spring and fall months before the summer and winter construction periods. SOHIO estimates that approximately one-half of its annual Haul Road tonnage is carried during the first four months of the year (Brovald, 1981). Exploration drilling occurs during the winter months, and major construction projects related to field development occur during the summer.

3.1.4. AIR FREIGHT

Table 12 (page 49) shows tonnages carried to North Slope locations in 1980 by Alaska International Air, Inc., which operates a fleet of Hercules cargo planes. The data are instructive as to the role that the air mode plays in oil and gas development activities in the Arctic. Exploration activities in 1980 were underway in both NPR-A and the Beaufort Sea. For

these two areas, air support occurred predominately during the first half of the year. For NPR-A, 99 percent of tonnage was transported from January to June and for Beaufort sites the figure was 87 percent. The first quarter produced by far the greatest tonnage for NPR-A destinations while for the Beaufort sites it occurred during the second quarter. At Prudhoe Bay (Deadhorse), where continuing development activities occur, air tonnage was greatest during the second half of the year which, accounting for 87 percent of the yearly total.

It should be noted that tonnages carried by land modes and air modes during the same time of the year are serving different activities. Due to the premium for air deliveries, that mode generally serves activities as they are happening, while the land mode is used to maintain a three to four month inventory of materials at distribution points or work sites.

3.2 Alternative Crude Oil Routes

Figure 6 shows the possible routes for the movement of oil to markets from the North Slope. The choice of routes depends upon the location and the size of fields. Location factors include distance from existing facilities and from favorable port sites.

Lease sites in the outer continental shelf of the Beaufort Sea are shallow. The outer limits are approximately at the 66 foot (20 meter) isobath. Icebreaking tankers would require a minimum of thirty meters (98 feet) which might require a loading facility 25 miles offshore. In a 1979 report (Bregha), the probable upper limit for artificial gravel islands was given as 50 feet (15.2 m), which would include much of the Beaufort Sea lease areas. Recently, the development of new construction techniques for

gravel islands makes them feasible in water depths as great as 80 feet (24.4 m) (Hoos, 1981). A major problem associated with production from offshore gravel islands is providing adequate protection against ice scour in the landfast ice zone for pipelines carrying oil ashore. Transportation of crude oil by tanker does have the advantage of an economic threshold for discovered reserves as low as one-tenth that for pipelines.

The Maritime Administration of the U.S. Department of Commerce is in the third year of a seven year study to determine the economic feasibility of specially designed tankers transporting oil through the Arctic Ocean. As part of this project, a U.S. Coast Guard icebreaker, the Polar Star, travelled to Point Barrow in February, 1981. Because of several minor mechanical problem experienced soon thereafter, the ship was forced to winter over in the Arctic ice. The problems experienced were not of the type to indicate that the use of icebreaking tankers on a year-round basis would be infeasible (Murphy, 1981).

Based on the experience of Dome Petroleum in the Canadian Beaufort and technological advances in icebreaker design in other countries, particularly Finland and Russia, there is little doubt that an icebreaking tanker can be designed to safely transport oil year-round in Arctic waters. The major problem associated with shipment of crude oil by the marine mode is not the vessel but the production platform. Mr. Francois Bregha of the Canadian Arcti Resources Committee pointed out in 1979 that:

> The greatest technological challenge facing an arctic marine oil trasportation system would probably not involve ship design as such, but rather the construction of an exposed-location, single-point mooring terminal on the North Slope capable of resisting the onslaught of the polar ice pack. Because of the shallowness of the Beaufort Sea, such a terminal would have to be built approximately forty kilometres offshore to accomodate the very large crude carriers that would carry North Slope oil. The terminal

> would have to be able to provide secure mooring, of course, but also be capable of loading cargo and processing the dirty ballast water quickly ..... No termimnal to meet conditions similar to those prevailing in the Beaufort Sea has ever been built (Bregha, 1979).

Mr. Bregha concludes that the possibility of moving North Slope oil to market by icebreaking tankers is remote in the short to medium-range future although he maintains the situation is subject to change. He offers eight reasons, as follows, to support his position:

1. Very large areas of the North Slope and Beaufort Sea are presently closed to commercial exploration.
2. The U.S. leasing process is slow.
3. An overland transportation corridor already exists.
4. The construction of offshore loading terminals poses many unresolved technical difficulties.
5. The cost of petroleum development in northern Alaska is very high.
6. The environmental risks associated with Arctic marine oil transportation are substantial.
7. Considerable inertia exists within the U.S. government on the subjects of both Arctic and energy policy.
8. More attractive investment opportunities in oil development exist elsewhere in the United States and the world.

Despite the significant problems associated with marine movement of Arctic oil, the potential of significant cost savings compared to use of TAPS could lead to an acceleration of work in addressing them. Present tariffs charged by owners of TAPS for transporting one barrel of oil from Prudhoe Bay to Valdez ranges from $6.04 to $6.44. These figures are approximately two-thirds of the $9 figure used in the NPR-A Section 105(b) economic report for moving oil to Long Beach. Recent cost studies for ice-breaking tankers have produced figures for a comparable journey of

$3.18-$5.06 per barrell (Bregha, 1979). The cost savings over TAPS might be even larger if demand for use of the pipeline required expansion beyond two million barrels per day.

The tanker routes shown in Figure 4 show transfer facilities which would be located in ice-free waters. It would not be cost-effective to utilize the high-powered ice breaking tankers in open water. Transfer facilities for the western route most likely would be located in the Aleutian Islands and for the eastern route on the coast of Greenland or Newfoundland.

The desire of the Canadian and U.S. governments each to have its oil and gas production consumed within its borders and strong east coast markets combine to favor development of the Northwest Passage as the primary tanker route. Dome Petroleum, which is solidly committed to this strategy, would benefit from an economy of scale if the route is also used by tankers from Alaska and the Canadian eastern Arctic.

Currently, as much as 500,000 barrels of oil from TAPS reaches the eastern United States via the Panama Canal. Construction of a pipeline across Panama with a capacity of 700,000 barrels is likely by 1982 (Business Week, 1981). It is estimated that wih a Panamanian pipeline transportation costs can be reduced by $1 per barrel and that transit time can be reduced by six days. The project can be justified even if the Northern Tier pipeline is built since it will not be in operation until at least the mid-1980's.

4.3 Alternative North Slope Gas Routes

Figure 7 shows the alternative routes for the movement of North Slope

gas. The alternatives are limited because of the difficulty of transferring gas from one mode of transport to another and because of the high cost of gas liquefaction. The Alaska Highway Gas Pipeline System appears to be the most probable alternative for moving North Slope gas to markets. It should be noted, however, that large discoveries of gas in the western portion of NPR-A could make feasible a gas liquefaction plant in the Cape Thompson/Pt. Lay area.

Table 15 summarizes the evaluation of alternative routes for use in different phases of oil and gas activities on the North Slope.

The information in the table points up the differences in the importance of alternate routes for the various oil and gas activities on the North slope to meet requirements for logistics and the transportation of recoverable oil and gas. The air mode was very important in the exploration and early development of the Prudhoe Bay field until the Haul Road was completed. Similarly, the air mode for NPR-A will be very important since no year-round surface transportation route exists. The sealift is particularly important during the development phase when large modules are required but is also important for other phases when an activity is not connected to the Haul Road. The Mackenzie River primarily serves as an alternate route than can be used instead of the Haul Road for areas in the eastern part of the Beaufort Sea. The importance of the Haul road to an area varies the most of any of the route options for transportation of inbound supplies. As the distance from Prudhoe Bay increases, the likelihood of a connecting road decreases. Ice roads are essential for exploration work both onshore and offshore and for later offshore phases. For onshore fields, generally year-round roads will be built in conjunction with pipelines to marine terminals to to TAPS.

Table 15

Summary Evaluation of Alternate Transportation Routes for North Slope Oil and Gas Activities

	Inbound Logistics				
Activity	Air	Sealift	Mackenzie River	Haul Road	Ice Roads
Prudhoe Bay					
Exploration	Very Imp.	Very Imp.	Useful	Unavail.	Necessary
Development	Very Imp.	Very Imp.	Useful	Very Imp.	Necessary
Production	Useful	Imp.	Alt. Route	Very Imp.	Unnecessary
Kuparuk Field					
Exploration	Useful	Useful	Alt. Route	Very Imp.	Necessary
Development	Useful	Very Impt.	Alt. Route	Very Imp.	Necessary
Production	Useful	Useful	Alt. Route	Very Imp.	Unnecessary
Western Arctic Management Area (NPRA)					
Exploration	Very Imp.	Very Imp.	Alt. Route	Pos. Useful	Necessary
Development	Very Imp.	Very Imp.	Alt. Route	Pos. Useful	Necessary
Production	Imp.	Imp.	Alt. Route	Pos. Useful	Useful
Beaufort Sea (1979 Sale)					
Exploration	Useful	Useful	Alt. Route	Imp.	Necessary
Development	Useful	Imp.	Pos. Useful	Imp.	Necessary
Production	Useful	Useful	Pos. Useful	Imp.	Useful
Eastern Beaufort Sea (Dome Petroleum)					
Exploration	Useful	Imp.	Imp.	Not Useful	Necessary
Development	Useful	Imp.	Imp.	Not Useful	Necessary
Production	Useful	Useful	Useful	Not Useful	Useful

Table 15 (Continued)

Summary Evaluation of Alternate Transportation Routes for North Slope Oil and Gas Activities

Activity	Oil and Gas Production Movement				
	TAPS Pipeline	Separate Oil Pipeline	Arctic Ocean Tankers	Pipeline to Chukchi Sea	Gas Pipeline
Prudhoe Bay					
Exploration	Yes				Yes
Development					
Production					
Kuparuk Field					
Exploration	Yes				Yes
Development					
Production					
Western Arctic Management Area (NPRA)					
Exploration	Possible	Possible	Possible	Possible	Possible
Development					
Production					
Beaufort Sea (1979 Sale)					
Exploration	Probable	Unlikely	Possible	No	Probable
Development					
Production					
Eastern Beaufort Sea (Dome Petroleum)					
Exploration			Yes		Probable
Development					
Production					

Source: Peter Eakland and Associates, 1981.

Of the five areas listed, transportation options for the movement of oil and gas appears to be set for three of them, given construction of the Alaska Highway gas pipeline. Production from both Kuparuk ad Prudhoe Bay will be by pipelines. Tankers appear to be the only feasible option for transporting oil from Canadian Beaufort Sea fields. For gas, however, use of a gas pipeline would be preferable. The LNG tanker technolgoy being tested by the Arctic Pilot Project in Canada's eastern Arctic could possibly be utilized also. Transportation of recoverable oil and gas reserves from the Alaskan Beaufort Sea and NPR-A will depend upon the size of discoveries and their location. Use of existing pipelines is more likely for Beaufort Sea discoveries. Nevertheless, most NPR-A tracts selected for leasing are in the eastern ssection of the reserve.

4.0 TRANSPORTATION DEMANDS AND FORECASTS

4.1 Introduction

This chapter discusses transportaion demands for base case conditions and the impacts of these demands on transportation systems in the primary and secondary study area. The chapter is divided into three sections. First, transportation demands are described for existing and forecast oil and gas activities on the North Slope. Recent activities are described where they are related to or indicative of future transportation demands or patterns. On the basis of this information and that contained in previous chapters, percentages of each major cargo type travelling by each major route are estimated. Finally, base scenario demands and their associated are described for each mode serving the study area.

4.2 Transportation Demands by Activity

The timing and extent of other oil and gas activities on the North Slope will affect impacts that might result from the second Beaufort Sea lease sale. Background information on the likely amount of oil and gas to be produced from these other aeas and the likely routes for logistics and movement of oil and gas to market is particularly useful in establishing baseline conditions for assessing impacts of Sale No. 71. Information on each of the major activity areas is presented below.

4.2.1 NATIONAL PETROLEUM RESERVE-ALASKA

NPR-A consists of 23 million acres on the North Slope stretching from the Colville River on the east to Icy Cape on the west and from the Arctic Ocean on the north to the continental divide on the south. Barrow is located approximately in the middle of the northern boundary. From 1923 to 1977, NPR-A was under the control of the Department of the Navy. Extensive drilling, seismic tests, and geologic mapping took place between 1944 and 1953. The 36 test wells and 44 core tests located nine oil and gas fields. The largest oil field discovered is located near Umiat and contains an estimated 70 million barrels of recoverable oil. The Barrow gas field, which has been developed for local use, was the largest gas field discovered. After almost a quarter century of no further drilling, the Navy renewed exploration activities in 1976. Seven wells had been drilled by the following year, at which time jurisdiction of the area was transferred to the Department of the Interior. During the next four years, an additional 21 wells were drilled.

The eastern, northern, and northwestern sections of NPR-A are believed to have the greatest potential for oil and gas. Of the 15 USGS activity areas, four of the five with the highest estimated average value of oil barrel equivalents in place are located north of NPR-A's southeastern boundary. The distribution of oil and gas varies signifcantly. Approximately 40 percent of the estimated gas reserves are located in northwestern NPR-A, while 50 percent of the oil is found in the southeast. Table 16 provides overall figures for the mean scenario of oil and gas in place, oil and gas delivered, minimum commercial pool sizes, and

Table 16

NATIONAL PETROLEUM RESERVE - ALASKA

Mean (Average) Probability Level
of Oil and Gas Activity

Oil in Place	7.10 billion barrels
Gas in Place	14.12 trillion cubic feet
Delivered Gas	3.74 trillion cubic feet
Delivered Oil	1.85 billion barrels
Minimum Commercial Oil Pool Size	78.60 million barrels
Minimum Commercial Gas Pool Size	1.10 trillion cubic feet
Probability of Commercial Oil or Gas Discovery	97.30 %

Source: Final Report of the 105(b) Economic and Policy Analysis, prepared by U.S. Department of the Interior, 1981.

probability of a commercial discovery. An oil field of approximately 80 milliom barrels of recoverable oil is required to support by itself the costs of development, production, and transportation, according to the the Department of Interior's 1979 economic analysis.

4.2.1.1 Transportation of oil and gas

The Department of the Interior, in its 1979 report entitled Final Report of the 105(b) Economic and Policy Analysis, analyzed options for transporting oil and gas from NPR-A to market. Four transportation options were considered, three of which centered on the Trans Alaska Pipeline (TAPS) and the Alaska Highway Gas Pipeline System (AHGPS). The baseline option assumed existing capacities for the two pipelines would be available to transport NPR-A resources. Given this assumption, the amount of oil and gas using these pipelines from sources other than NPR-A becomes critical. Should total demand exceed the capacity of these pipelines, either looping or construction of a parallel pipeline would be required. The incremental costs of these options are considerable, particularly for new pipelines, and would significantly affect the economics of new fields. A sensitivity analysis tested the effects on the baseline option of different capacities in the oil and gas pipelines available to NPR-A reserves. The second and third options, respectively, assumed an increase in the availability of AHGPS capacity and a decrease in the availability of TAPS capacity. The fourth option assumed tranportation of oil and gas reserves by pipeline to terminals at either Cape Thompson or Pt. Lay. Assumptions for each of the options are provided below:

Capacity Assumptions

Option 1: Baseline

- TAPS - 500,000 barrels per day.
- AHGPS - 1.2 billion cubic feet per day.

Option 2: Increased AHGPS Capacity

- TAPS - 500,000 barrels per day.
- AHGPS - 2 billion cubic feet per day.

Option 3: Reduced TAPS Capacity

- TAPS - 250,000 barrels per day.
- AHGPS - 1.2 billion cubic feet per day.

Common Assumptions for TAPS and AHGPS Options 1-3

- total oil transportation costs will be $9 per barrel from NPR-A to Long Beach.
- average gas transportation cost will be $4 per thousand cubic feet from NPR-A to San Francisco or Chicago.
- the price of oil in 1978 dollars will be $30.000 per barrel in 1986.
- the price of gas in 1978 dollars will be $7.00 per thousand cubic feet in 1986.

Option 4: Cape Thompson/Pt. Lay Option

- costs of using either Cape Thompson or Pt. Lay would be essentially the same.
- gas would be carried in ice-breaking LNG tankers to Pt. Conception (north of Long Beach).
- oil would be carried to Long Beach in 280,000 DWT tankers.

Table 17 provides a comparison of the four transportation options studied. For the base case, total undiscounted transportation costs are 57 percent of total undiscounted costs and amount to $16.8 billion. Should available capacity of the gas pipeline be increased (Option 2), more gas would be delivered. Transportation costs would be increased but would remain approximately the same percentage of total costs. Reduction of available capacity in TAPS (Option 3) would cause a decrease in oil deliveries. Transportation costs are actually higher in Option 3 than those in Option 1 since they are a higher percentage of total costs. The same effects on oil delivries and transportation costs occur for Option 4 but are even more pronounced. The percentage of transportaion costs rises to 67 percent and the amount of delivered oil is reduced to 1.56 billion barrels. For gas in Option 4, delivered gas is lower than for the other options, but the percentage for transportation costs is approximately the same. It is worth noting that at the five percent (high) resource scenario, delivered gas is increased over the figure for the baseline transportation option. The report suggests two reasons for this result. First, the gas reserves tend to be located in the western section of the reserve; and second, the pipeline can be accurately sized for the reserves.

4.2.1.2 Exploration Logistics

The USGS managed drilling activities in NPR-A from 1978 to 1981. Logistics for the drilling operations involved the use of marine, land, and air modes. The utilization of modes varied significantly between seasons. Marine shipments to the North Slope occurred during the short summer shipping season, and land movements occurred only during the winter. Air

Table 17

IMPLICATIONS OF TRANSPORTATION OPTIONS ON MEAN RESOURCE LEVEL DISCOVERIES

	1 TAPS/AHGPS Baseline	2 AHGPS Incr. Capacity	3 TAPS Red. Capacity	4 Western Alaska
Delivered Oil (billion of barrels)	1.85	Same as Baseline Option	1.80	1.56
Total Oil Transportation Costs (billions of 1978 dollars)	16.75		19.37	19.41
Transportation Costs as a Percentage of Total Costs	57 %		62 %	67 %
Transportation Costs per Barrel (1978 dollars)	9.61		11.30	13.74
Exploratory Wells	15.60		15.60	15.30
Producing Fields	3.20		3.10	2.40
Miles of Pipeline Constructed	308.00		303.00	376.00
Delivered Gas (trillions of cubic feet)	3.74	4.46	Same as Baseline Option	3.08
Total Gas Transportation Costs (billions of 1978 dollars)	14.53	16.54		12.06
Transportation Costs as a Percentage of Total Costs	78 %	78 %		79 %
Transportation Costs per Thousand Cubic Feet (1978 dollars)	3.98	3.84		3.99
Exploratory Wells	25.40	25.40		24.20
Producing Fields	1.40	1.50		0.80
Miles of Pipeline Constructed	216.00	235.00		153.00

Source: Final Report of the 105(b) Economic and Policy Analysis, prepared by U.S. Department of the Interior, 1981.

cargo shipments took place during the winter to ice runways and on an all-year basis to gravel strips and to the primary support bases at Camp Lonely, Barrow, and Umiat.

For the marine mode, the major receiving point was Camp Lonely, a DEW line site located southeast of Barrow at Pitt Point. Drilling equipment was brought ashore at two other locations, one east and the other west of Wainright (Stout, 1981).

Cat trains were used to haul equipment inland from the marine delivery sites and to move equipment from one drill site to another after completion of a well. Overland travel was accomplised only during the winter months and then only on approved trails.

To support the project, the Federal government lengthened the runway and made surface improvements at Lonely. Ice runways were constructed at most of the drilling sites at costs ranging from $30,000-$50,000 depending upon weather, site conditions, and intended life of the facility. Three gravel airstrips to support year-round drilling were constructed whre drilling could not be accomplished in one winter. The maximum well depth that can be drilled in one winter is approximately 10,000 feet (3,048 km). Gravel had to be hauled a minimum of six and maximum of 36 miles (9.7 to 58 km) to construct the strips. Due to the limited fuel storage capacities at drilling sites, as well as at Lonely, much fuel had to be flown in to support drilling and logistics activities.

4.2.1.3. 1981 Lease Sale

The first lease sale in NPR-A will take place in December 1981 and will cover over 2.3 million hectares located primarily in the southern and southeastern areas of the reserve. The recent logistics activities used to

drill exploratory wells in NPR-A are similar to those that are expected in coming years. The use of the Haul Road as a major logistics route is unlikely because of the river crossings that would be required. Air travel will be the primary year-round mode of transportation, and barge deliveries of goods at centralized operating bases such as Camp Lonely will occur during the short summer shipping season. The Bureau of Land Management estimates that a total of 22 exploratory wells be drilled from 1982 through 1988 and that field development will begin in 1987 (U.S. Department of the Interior, 1981b).

4.2.2 KUPARUK

Located 27 miles (43.4 km) to the west of Prudhoe Bay, the Kuparuk field was discovered in 1969 but is only now being developed. The estimated potential recoverable reserves of 750 million barrels of oil are approximately eight percent of Prudhoe Bay's estimated 9.6 billion barrels of recoverable oil. Although Kuparuk's reserves are closer to the surface, artificial pressure must be applied to recover them. The costs of this procedure have held back development until the recent world-wide escalation of oil prices.

Forty wells initially will be drilled at five Kuparuk sites, and daily production will be 80,000 barrels. Additional drilling of development wells is expected from 1982 to 1988. At full development of the field, potential daily flows could be as high as 200,000 barrels (Kossen, 1981).

A 16-inch (40.6 cm) insulated pipeline will carry the oil to the Trans-Alaska Pipeline at Prudhoe Bay. Separate bridges are being built for the pipeline and for truck travel. The mile-long (1.6 km) pipeline bridge

has been designed to accommodate additional pipelines iun the future. The vehicle bridge, which will have a 300 foot (91.4 m) span, can support loads up to 1,700 tons (1,542 metric tons). Heavy modules began moving overland to Kuparuk from Prudhoe Bay in 1981.

The Atlantic Richfield Co. estimates that in 1981 approximately one-third of all freight arriving at Prudhoe Bay is related to the Kuparuk project (Edmunds, 1981). Virtually all of the freight destined for Kuparuk will be shipped by road via Prudhoe Bay. However, the airstrip at Kuparuk is being extended to 6,000 feet (1,829 m) so that it can accommodate Hercules cargo aircraft. There is a possibility that a port facility will be developed at Oliktok, a DEW line site due north of Kuparuk, but its development would probably also require major activities in the eastern section of NPR-A.

4.2.3 PRUDHOE BAY

4.2.3.1 Waterflood Project

The Prudhoe Bay waterflood project will provide water injection into oil fields to increase the amount of recoverable oil. The project will begin in 1982, and the first phase will be completed in 1984. An addition, scheduled for the following year, will provide a 33 percent increase in capacity. The project will double existing pipelines at Prudhoe Bay.

A seawater intake and treatment plant will be located at the end of an extension to the west Prudhoe Bay Causeway. As part of the project, the causeway itself will be widened from its present width of 44 feet (13.4 m) to between 71 (21.6 m) and 105 feet (32 m) depending upon the water depth.

Water will be piped from the plant to two injection plants, requiring a total o 29 miles (46.7 km) of low-pressure pipeline. From these plants, 99 miles (159 km) of high-pressure pipelines will take the water to 28 well pads. An estimated 154 wells will be drilled as part of the project. A total of 76 modules will be shipped to Prudhoe Bay for the project, 43 in the summer of 1983 and 33 the following year.

The Final Environmental Impact Statement for this project included a brief analysis of potential transportation impacts. An excerpt follows:

> This schedule of material movement to Prudhoe Bay is compatible with other logistical needs for the area including Kuparuk field development, gas conditioning plant construction, and gas line construction. Proposed modificaions to DH 3 (west dock) and the existing causeway would allow 6-8 barges to unload simultaneously and two-way traffic on the causeway, thus greatly increasing capacity of the dockhead and causew3ay. The modifications proposed take into account transportation needs for the other developments mentioned above. Haul road traffic and air traffic would increase somewhat, but not significantly. Therefore, no logistics conflicts with other planned or potential projects would be anticipated. If major developments in the Prudhoe Bay area, such traffic would be significantly greater than at present. The cumulative effect of increased transportation relates primarily to increased sea traffic.

4.2.3.2 Prudhoe Bay Field Development

The Prudhoe Bay field at present is still only half-developed.

Development activities will continue throughout the 1980's. The existing 500 wells could double to 1,000 at full development (U.S. Corps of Engineers, 1980).

4.2.4 ARCTIC NATIONAL WILDLIFE REFUGE

Exploration activities in the Refuge can be conducted and are expected to last five years. Development drilling cannot occur unless approved by Congress.

4.2.5 CANADIAN ARCTIC ACTIVITIES

Oil and gas activities in the Canadian Arctic differ in many respects from those currently underway or planned for the Alaskan North Slope. Most of the Canadian Arctic reserves lie offshore as opposed to onshore, and water depths of most promising fields are greater than in Alaskan Beaufort Sea lease sale tracts. Canadian companies are more advanced than their American counterparts in the development and testing of equipment and procedures to explore, develop, and produce offshore Arctic fields. Delivery of oil to markets most likely will be by ice-breaking tankers, but for natural gas a pipeline connection to the Alaska Highway gas line is the most likely possibility. Liquid natural gas (LNG) tankers become a virtual necessity if AHGPS is not built.

Work underway in the eastern and western Canadian Arctic will help decide the feasibility of using oil and LNG tankers to move reserves produced on the North Slope of Alaska to market from locations distant from the existing pipeline system.

In Canada's eastern Arctic, the Arctic Pilot Project will deliver natural gas from Melville Island in the Northwest Territories to a Newfoundland port. Daily production from eight wells will be 250 thousand cubic feet. The ice-breaking LNG ships to be used are designed to carry 4.9 million cubic feet of natural gas and to break ice eight feet thick (2.4 m). They will be 1,230 feet long (375 m), have a beam of 43 feet (13.1 m), and a draft of 38-43 feet (11.6-13.1 m) (Petro Canada, 1980).

Dome Petroleum has undertaken extensive exploratory drilling in the Canadian Beaufort. As part of these activities, it has tested and refined techniques for the construction of artificial islands and has also designed and tested vessels to support Arctic offshore drilling operations. It had constructed 15 artificial islands by 1979, and its drillships first arrived in the Beaufort Sea in 1976.

Table 18 shows the existing Dome fleet operating in the Canadian Arctic and proposed additions. Construction is scheduled to begin on a fleet of 20 ice-breaking tankers by 1983. These vessels will have a draft of approximately 65 feet (19.8 m) and a Class 10 designation, which means that they will be able to break ice ten feet (3.0 m) thick while moving continuously at three knots. On the basis of successful tests with its experimental Class 4 icebreaker, Dome feels that the largest support icebreaker required will be a Class 6 rather than a Class 10 as earlier thought. Dome anticipates being able to transport oil either east through the Northwest Passage or west through the Bering Straits. Market conditions initially favor the Northwest Passage route.

In a 1979 speech, Mr. G. R. Harrison of Dome Petroleum, reported what he felt were achievable goals for his company during the coming decade. They were as follows:

Table 18

Dome Petroleum Co., Ltd.
Beufort Sea Fleet

Existing Fleet

Type of Vessel	Number
Drillships	4
Ice-breaking Supply Boats	8
Class 4 Ice-breaker	1
Ocean-going Barges	3
Large Supply Vessel	1
Total Existing Fleet	16

Proposed Fleet Additions

Type of Vessel	Number	Year Construction to Begin
Suction Dredges	12	1981
Hopper Barges	15	1981
Icebreaking Tankers (200,000 DWT, 150,000 hp)	20	1983
Swivel Drillships	2	1982
Icebreakers	5	1984(one per year)
Safety Vessels	4	1983(one per year)
Storage and Process Barges	4	1982
Drilling and Production Barges	4	1983(two per year)
Supply Boats	12	1985(three per year)
Accomodation Barges	8	1983(two per year)
Total Additional Fleet	90	

Source: "Marine Engineering/Log", November; 1980; p. 108.

1. Except in the permanent polar pack region, year-round exploratory drilling by 1981-1982, and year-round petroleum production and transportation by 1983-1984;
2. For the permanent polar pack regions, year-round drilling by 1984 and production by 1987, and
3. Year-round marine traffic through the Northeast and Northwest Passages by 1982.

4.2.6 JOINT FEDERAL/STATE BEAUFORT SEA OUTER CONTINENTAL SHELF LEASE SALE (1979)

The U.S. Department of the Interior, in its final environmental impact statement for the joint Federal/State Beaufort Sea OCS lease sale that for the mean scenario that 20 exploration wells would likely be drilled and 114 production wells. Exploration activities began in 1981, and the logistics to prepare for and undertake drilling offshore in the Beaufort Sea have been shown to be relatively complex and involve a wide variety of transportation modes.

Construction of gravel islands is accomplished both by using barges during the summer and trucks on ice roads during the winter. The barges load up with gravel at one of the docks in Prudhoe Bay. They can remain in service as late as November 1. Then there is a period of a month or so when the ice is too thick for the use of barge but not quite thick enough to support trucks with heavy loads. From December 1 to March or April, light freight and personnel are transported to work sites from Prudhoe Bay by helicopers and airplanes. Drilling rigs are removed by the end of March and moved to their summer location.

Exploration drilling will take place only during the winter months. Year-round actsivities will commence when the development phase begins. Helicopter transportation demands will be greatly increased. The use of barges/work boats during the summer and trucks during the winter to move bulky or heavy supplies can be expected to continue. Oil companies try to use all available transportation services.

In the exploration phase, logistics activities must rely on the existing infrastructure, and conflicts can arise with ongoing development activities in the Prudhoe Bay area. In particular, there are many potential users for the dock space during the limited time that loading and unloading of vessels can take place. At present, the first priority is given to unloading of modules needed for Prudhoe Bay development. Development drilling in the Beaufort Sea is not expected until 1986, at which time sealift activities will have dimininished somewhat. By that time, also, a support base to the east or west of Prudhoe Bay could be a reality.

4.2. SUMMARY

Table 19 shows the estimate of drilling activity on the North Slope during the next twenty years and associated tonnage. Despite the use of rough estimates, several facts emerge which are important in assessing the impacts of future lease sales. A large part of the drilling to take place during the next decade will be related to further development of fields already discovered and in production,

Table 19

FORECASTS OF NORTH SLOPE DRILLING ACTIVITIES AND ASSOCIATED TONNAGE

Activity	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Beaufort Sea Sale-1979																				
Exploration	2	6	6	7	2	1														
Development						3	12	21	24	18	12	10	4	4	4	2				
Kuparuk																				
Phase 1	20	20																		
Later Phases		5	10	20	15	10	5													
Pt. Thompson-Lisburne																				
Exploration	5	5	3																	
Development			10	20	35	30	25	25	15	10										
Waterflood Project																				
Drilling		50	50	50																
Prudhoe Bay Development	20	20	20	20	15	15	15	10												
NPR-A																				
Exploration		1	3	4	5	5	2	3												
Development							30	30	60	75	60	60	60	30	30					
Total																				
Exploration	7	11	9	7	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Developmemt	40	95	90	110	65	58	60	59	45	36	18	16	10	7	7	2	0	0	0	0
Tonnage (1) (Thousands of Tons)	61	135	125	146	83	73	73	72	54	43	22	19	12	8	8	2	0	0	0	0

Note: (1) Tonnage based on tonnage only for dry goods. Assumed tonnage 1,822 tons for each exploration well and 1,204 tons for each development well. Only ten percent of the estimated tonnage for NPR-A wells is assumed to pass through Prudhoe Bay. The factor 0.90718 can be used to convert tonnage figures into metric tons.

Source: Peter Eakland and Associates, 1981.

i.e. Kuparuk and Prudhoe Bay. Major drilling activities after 1985 are expected to bein the first Beaufort Sea lease sale area, the Pt. Thompson - Lisburne area, and in NPR-A. The largest amount of activity will be in NPR-A but much of it will be far inland and will be independent of other activities, except that production probably would use TAPS to get oil to markets.

4.2. POPULATION-RELATED TRANSPORTATION DEMANDS

Although the focus of this report is on logistics of freight associated with North Slope oil and gas activities during the next 20 years, population-related demands are also of interest.

Table 20 shows a comparison of the population forecasts for Southcentral Alaska and Fairbanks which were developed for two separate projects -- the baseline (no sale) analysis of Beaufort Sea Sale No. 71 and the 1980 Electric Power Study of the Railbelt Region. The total population figures represent the market area for freight entering Southcentral ports. The 1990 and year 2000 Sale No. 71 forecasts are slightly larger than the corresponding figures used in the power study but are close enough that the two sets of forecasts can be used interchangeably. Since the same forecasts used in the power study were also used in the Corps of Engineers' Southcentral Region of Alaska Deep-draft Navigation Study, the freight forecasts made in the latter study can be assumed to be valid for this study.

Population forecasts at the regional an local level, where used, are based on forecasts make as part of the Western and Arctic Alaska Transportation Study.

Table 20

Comparison of Population Forecasts Used in Sale No. 71 Baseline and Southcentral Region Deep-Draft Navigation Study

	1980	1990	2000
POPULATION (NO. 71 BASELINE)(1)			
ANCHORAGE	181965	247662	318366
SOUTHCENTRAL	49681	67096	79893
FAIRBANKS	56137	84635	107553
TOTAL	287783	399393	505812
POPULATION(LEVEL B)(2)			
ANCH-SOUTHCENTRAL	227792	295545	388351
FAIRBANKS	59300	78900	100100
TOTAL	287092	374445	488451
% DIFFERENCE (3)	0.00	0.06	0.03

NOTES: (1) Forecasts are from Sale No. 71 Impact Study prepared by Institute of Social and Economic Research.
(2) Forecasts are from Level B economic scenario in 1980 Electric Power Study of the Railbelt Region.
(3) % Difference is the difference the Level B total forecast is from the Sale No. 71 baseline forecast.

4.3 Routing Selections by Cargo Type

The major cargo types considered are drilling supplies and modules required in the development of oil and gas fields. Tonnage for pipelines is considered to be in the same category as drilling supplies. It is estimated that 80% of all drilling supplies except those for NPR-A will reach the North Slope via Southcentral ports and the Haul Road. This estimate is based on recent traffic patterns. This route permits freight to remain on freight cars from origins in the Lower 48 as far north as Fairbanks if Whittier is used as the port of entry.

Since the route can be used year-round, inventories can be kept low. All freight on rail cars is assumed to enter Alaska at Whittier and all containerized freight at Anchorage. It is assumed that ten percent will travel via tug and barge on he Mackenzie River. The remaining ten percent is assumed to be placed on Arctic sealift barges as space permits. The principal purpose -- in fact, the sole purpose of the sealift for destinations accessible by road from Prudhoe Bay -- has become the transportation of modules. Drilling supplies are added to the barges as space permits, but in the absence of any modules, shipments would be carried on the Haul road or the Mackenzie River. Most modules are shipped during the field development phase. This phase will occur well into the 1990's for at least one North Slope activity area.

Once drilling supplies reach Prudhoe Bay by one of the three routes mentioned above, in many instances they can be transshipped to

onshore and offshore work sites even if a gravel road has not been constructed. Ice roads can be used during the winter for both offshore and onshore locations. Lightering craft, work boats, or hovercraft can be used at offshore locations during the summer months.

As distances from Prudhoe Bay increase, its usefulness as a distribution point decreases. For NPR-A, it is assumed that only ten percent of drilling supplies will first come to Prudhoe Bay. This freight would then be shipped overland during the winter or in some cases by air. The remainder would either arrive by barge at one or more coastal base camps or by air directly from Anchorage or Fairbanks.

Transportation of oil and gas is assumed to travel southward from the North Slope, respectively, by the TAPS and AHGPS pipelines. This assumption for oil is based on the availability of an existing pipeline system (TAPS) rather than economic or technological arguments. There is little doubt that oil will be transported by tanker from the Canadian Arctic by the mid or late 1980's. Dome Petroleum's aggressive work in testing new vessel designs and its plans to build its own shipyard on the west coast of Canada indicates a firm commitment to produce oil and gas from offshore fields. Flexibility is needed so that the oil can be transported either to the east or the west, and tankers provide this flexibility. Dome is hopeful that its gas production can be transported to the AHGPS via a feeder pipeline. However, for oil, no pipeline prospects exist at present, and tanker transportation, therefore, is essential. Production from the Kuparuk and Prudhoe Bay fields are committed to using TAPS. Pt. Thompson and Cape Lisburne are further away from

Prudhoe Bay than Kuparuk, but production from these areas probably would still use TAPS. Its use to transport Beaufort Sea and NPR-A production is less certain, particularly for the latter, but at least likely.

Use of the AHGPS to carry production from North Slope gas fields distant from Prudhoe Bay has a greater certainty than use of TAPS for oil. Tanker transportation can have a lower economic threshold than that for pipelines, but the large expenses of a gas liquification plant can produce the reverse situation for gas.

4.4 Transportation Demands and Impacts by Mode

4.4.1 WATER MODE

4.4.1.1 Southcentral Ports

4.4.1.1.1 Demands

Tables 21-24, respectively, show the inbound freight forecasts at ten year intervals for the ports of Anchorage, Whittier, Seward, and Valdez as contained in the Corps of Engineers' Southcentral Region of Alaska Deep-draft Navigation Study. Figures 8-11 show for the same ports the relationship between the forecasts and capacity for each major cargo type at the ports.

For Anchorage, the Corps of Engineers study made two separate forecasts. In one, it was assumed that Anchorage would continue to handle all containerized cargo with a Fairbanks destination. In the other, it was assumed instead that Valdez would attract fifty percent of this traffic. The 240,000 ton (217,723 metric ton) difference

Table 21

Port of Anchorage - Forecasts of Inbound and Outbound Cargo

BASELINE & DEVELOPMENT POTENTIALS INBOUND

(Alternative Routing: Port of Anchorage Handles Interior Alaska General Cargo)

CARGO HANDLING CATEGORY	THOUSAND TONS 1980	1990	2000	2010	2020	20
CONTAINER						
Baseline	808.6	1183.3	1726.1	2069.4	2492.8	291
Prudhoe Bay	-	126.0	23.0	23.0	-	-
Arctic Longrange	-	-	5.0	40.0	18.0	1
Beaufort Sea OCS	-	16.0	16.0	7.0	7.0	
Alaska Gas Pipeline	-	152.0	-	-	-	-
Healy Coal	-	1.0	2.0	2.0	2.0	
Susitna Hydro	-	8.0	17.0	-	-	
Total	808.6	1486.3	1789.1	2141.4	2519.8	293
NEOBULK/BREAKBULK						
Baseline	54.4	66.0	79.2	91.3	103.7	11
Prudhoe Bay	-	36.0	4.0	4.0	-	-
Arctic Longrange	-	-	2.0	20.0	5.0	5.
Beaufort Sea OCS	-	5.0	5.0	2.0	2.0	
Alaska Gas Pipeline	-	372.0	-	-	-	-
Susitna Hydro	-	-	3.0	-	-	-
Total	54.4	479.0	93.2	117.3	110.7	12
DRY BULK						
Baseline	218.6	375.7	542.9	690.0	847.2	1004.
Susitna Hydro	-	10.0	70.0	-	-	
Total	218.6	385.7	602.9	690.0	847.2	100
LIQUID BULK						
Baseline	990.7	990.7	990.7	990.7	990.7	99

BASELINE & DEVELOPMENT POTENTIALS OUTBOUND

1980 to 2030

(Alternative Routing: Port of Anchorage Handles Interior Alaska General Cargo)

CARGO HANDLING CATEGORY	THOUSAND TONS 1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	140.9	140.9	140.9	140.9	140.9	140.9
Alaska Gas Pipeline	-	74.0	-	-	-	-
Total	140.9	214.9	140.9	140.9	140.9	140.9
NEOBULK/BREAKBULK						
Baseline	10.0	10.0	10.0	10.0	10.0	10.0
DRY BULK						
Baseline	.3	.3	.3	.3	.3	.3
LIQUID BULK						
Baseline	3.3	3.3	3.3	3.3	3.3	3.3

Source: Southcentral Region Deep-Draft Port Study, prepared by Alaska Consultants, Inc. and and PRC Harris, Inc. for U.S. Corps of Engineers. 1981.

Figure 22

Whittier - Forecasts of Inbound and Outbound Cargo

Projections of Inbound Baseline and Development Resource Cargo Potential 1980 -2030 (Thousands of Tons)

CARGO HANDLING CATEGORY	1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	160.0	242.3	336.5	420.2	507.3	594.4
Prudhoe Bay	-	12.0	2.0	2.0	-	-
Arctic Longrange	-	-	1.0	4.0	2.0	2.0
Beaufort Sea OCS	-	2.0	2.0	3.0	3.0	-
Healy Coal	-	-	-	1.0	1.0	-
Susitna Hydro	-	2.0	7.0	-	-	-
Total	160.0	256.3	348.5	429.2	513.3	596.4
NEOBULK/BREAKBULK						
Baseline	40.1	48.7	58.4	67.3	76.4	85.6
Prudhoe Bay	-	4.0	1.0	1.0	-	-
Arctic Longrange	-	-	-	2.0	-	-
Beaufort Sea OCS	-	1.0	-	-	-	-
Total	40.1	53.7	59.4	70.3	76.4	85.6
DRY BULK						
Baseline	32.6	56.1	79.5	103.0	126.4	149.9
LIQUID BULK						
Baseline	19.3	19.3	19.3	19.3	19.3	19.3

(1) Prudhoe Bay Ongoing Development
- Inbound container and neobulk cargo flows peak in 1982 and are allocated to the 1990 decade potentials.

(2) Arctic Longrange
- Inbound container and neobulk cargoes peak during the 2000 through 2009 time frame and are allocated to the 2010 decade potentials

(3) Beaufort Sea OCS
- Inbound container and neobulk cargoes peak during the 1985 to 1995 time frame and are allocated to both the 1990 and 2000 decade potentials.

(4) Healy Coal
- Inbound container cargo peaks in 2011 and is allocated to the 2020 decade potential.

(5) Susitna Hydro Electric
- Inbound container cargo peaks in 1993 and is allocated to the 2000 decade potential.

Projections of Outbound Baseline and Development Resource Cargo Potentials 1980 - 2030 (Thousands of Tons)

CARGO HANDLING CATEGORY	1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	64.8	64.8	64.8	64.8	64.8	64.8
NEOBULK/BREAKBULK						
Baseline	23.0	23.0	23.0	23.0	23.0	23.0
DRY BULK						
Baseline	-	-	-	-	-	-
LIQUID BULK						
Baseline	1.3	1.3	1.3	1.3	1.3	1.3

Source: Southcentral Region Deep-Draft Port Study, prepared by Alaska Consultants, Inc. and PRC Harris, Inc. for U.S. Corps of Engineers. 1981.

Table 23

Seward - Forecasts of Inbound and Outbound Cargo

PROJECTION OF OUTBOUND BASELINE CARGO
1980 to 2030
(Thousands Tons)

CARGO HANDLING CATEGORY	1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	2.6	2.6	2.6	2.6	2.6	2.6
NEOBULK/BREAKBULK						
Baseline	-	-	-	-	-	-
DRY BULK						
Baseline	-	-	-	-	-	-
LIQUID BULK						
Baseline	-	-	-	-	-	-

Healy Coal Development

- Dry Bulk cargo will increase from one million tons in 1990 to 2.5 million tons in 2020.

PROJECTION OF INBOUND BASELINE AND
RESOURCE DEVELOPMENT CARGO POTENTIAL
1980 to 2030
(Thousand Tons)

CARGO HANDLING CATEGORY	1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	38.6	61.0	83.8	106.2	128.7	151.3
NEOBULK/BREAKBULK						
Baseline	1.5	1.8	2.2	2.5	2.8	3.2
DRY BULK						
Baseline	-	-	-	-	-	-
Healy Coal		1000.0	1500.0	2000.0	2500.0	2500.0
LIQUID BULK						
Baseline	16.6	16.6	16.6	16.6	16.6	16.6

Source: Southcentral Region Deep-Draft Port Study, prepared by Alaska Consultants, Inc. and PRC Harris, Inc. for U.S. Corps of Engineers. 1981.

Table 24

Valdez - Forecasts of Inbound and Outbound Cargo

BASELINE & DEVELOPMENT POTENTIALS INBOUND

1980 to 2030

(Alternative Routing: Port of Anchorage Handles Interior Alaska General Cargo)

CARGO HANDLING CATEGORY	THOUSAND TONS					
	1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	1.9	2.8	3.9	4.9	5.9	6.9
Alpetco	-	2.0	1.0	1.0	-	-
Alaska Gas Pipeline	-	101.0	-	-	-	-
Total	1.9	105.8	4.9	5.9	5.9	6.9
NEOBULK/BREAKBULK						
Baseline	.1	.1	.1	.2	.2	.2
Alpetco	-	375.0	-	-	-	-
Alaska Gas Pipeline	-	248.0	-	-	-	-
Total	.1	623.1	.1	.2	.2	.2
DRY BULK						
Baseline	-	-	-	-	-	-
LIQUID BULK						
Baseline	250.3	250.3	250.3	250.3	250.3	250.3

Source: Southcentral Region Deep-Draft Port Study, prepared by Alaska Consultants, Inc. and PRC Harris, Inc. for U.S. Corps of Engineers. 1981.

BASELINE & DEVELOPMENT POTENTIALS OUTBOUND

1980 - 2030

(Alternative Routing: Port Anchorage Handles Interior Alaska General Cargo)

CARGO HANDLING CATEGORY	THOUSAND TONS					
	1980	1990	2000	2010	2020	2030
CONTAINER						
Baseline	2.4	2.4	2.4	2.4	2.4	2.4
Alpetco	-	78.0	78.0	78.0	-	-
Alaska Gas Pipeline	-	88.0	-	-	-	-
Total	2.4	168.4	80.4	80.4	2.4	2.4
NEOBULK/BREAKBULK						
Baseline	-	-	-	-	-	-
DRY BULK						
Baseline	-	-	-	-	-	-
LIQUID BULK						
Baseline	55294.4	55294.4	-	-	-	-
Alpetco	-	7340.0	7340.0	7340.0	7340.0	-
Prudhoe Bay	-	-	55294.4	55294.4	55294.4	55294.4
Total	55294.4	62634.4	62634.4	62634.4	62634.4	55294.4

(1) Alpetco
- Outbound container and liquid bulk movements begin in 1985 and are expected to continue to 2005. These throughputs are allocated to the 1990, 2000 and 2010 decade potentials.

(2) Alaska Natural Gas Pipe Line
- Outbound container cargo peaks in 1985 and is allocated to the 1990 decade potential.

(3) Prudhoe Bay Ongoing Development/Arctic Long-Range/Beaufort OCS
- Liquid bulk assumes various developments maintain present levels of crude shipment through TAP line beyond exhaustion of currently proved reserves.

Figure 8

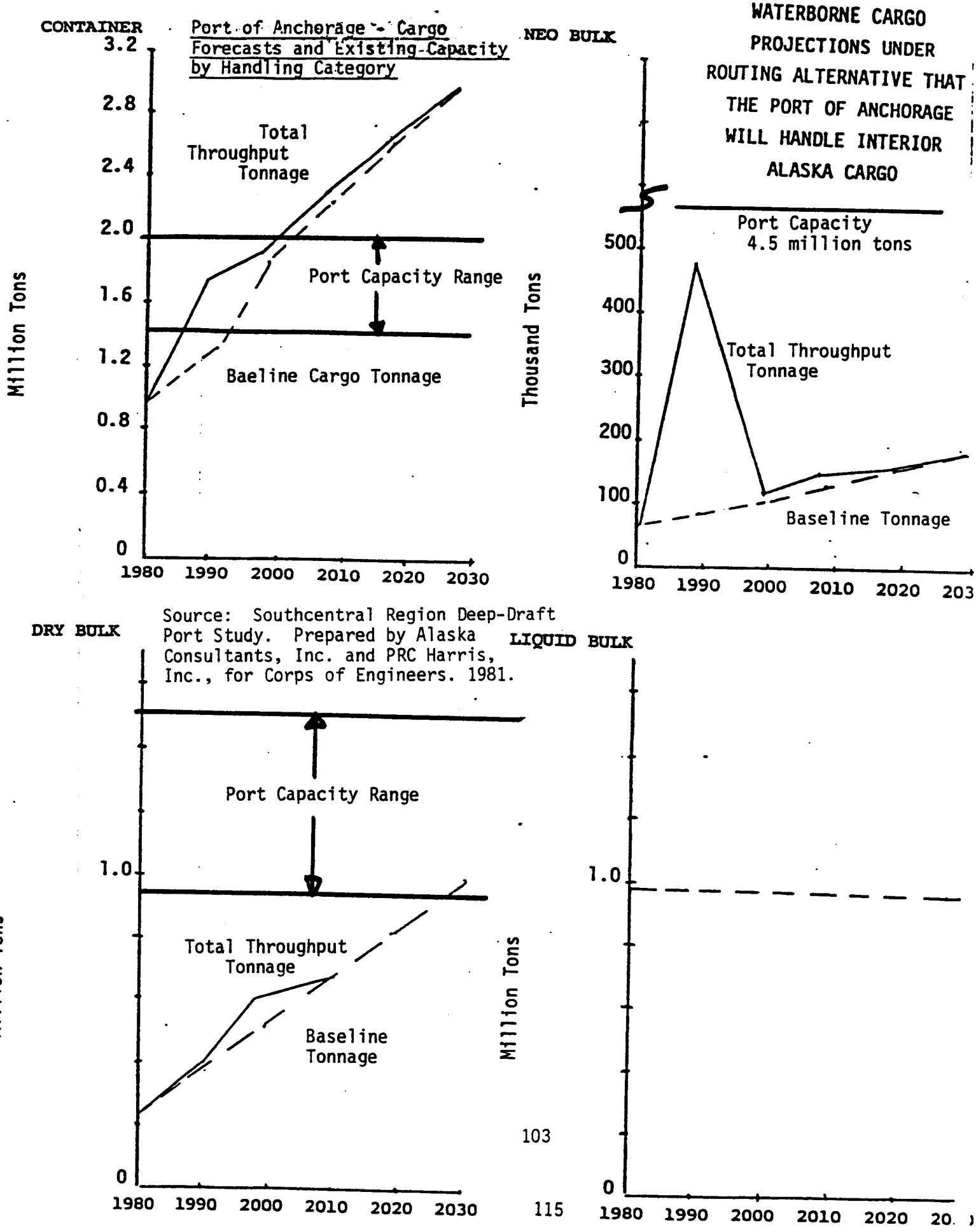
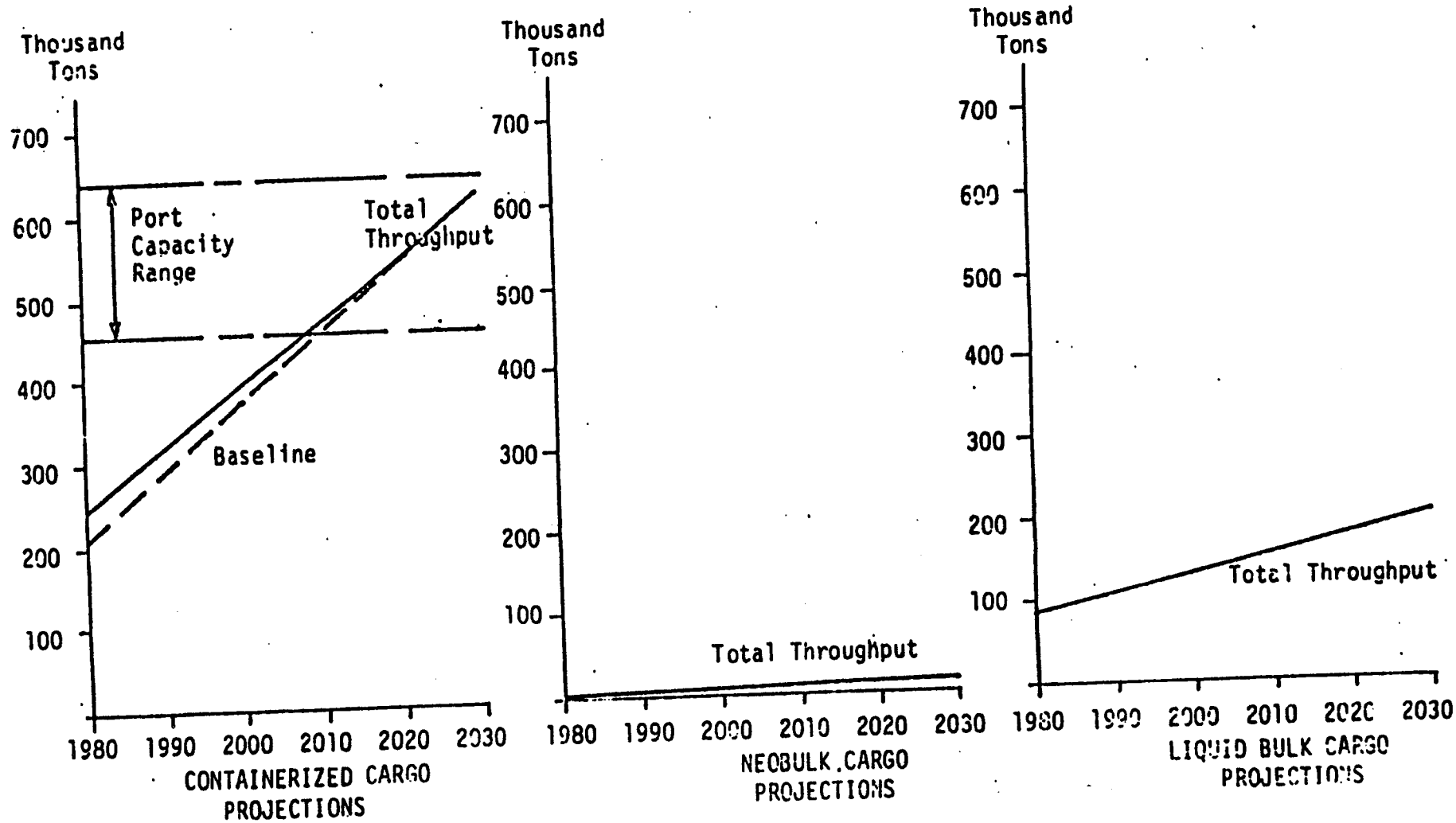

CONTAINER
Port of Anchorage - Cargo Forecasts and Existing Capacity by Handling Category
Million Tons
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0
Total Throughput Tonnage
Port Capacity Range
Baeline Cargo Tonnage
1980
1990
2000
2010
2020
2030
NEO BULK
WATERBORNE CARGO PROJECTIONS UNDER ROUTING ALTERNATIVE THAT THE PORT OF ANCHORAGE WILL HANDLE INTERIOR ALASKA CARGO
Thousand Tons
Port Capacity 4.5 million tons
500
400
300
200
100
0
Total Throughput Tonnage
Baseline Tonnage
1980
1990
2000
2010
2020
203
DRY BULK
Source: Southcentral Region Deep-Draft Port Study. Prepared by Alaska Consultants, Inc. and PRC Harris, Inc., for Corps of Engineers. 1981.
Million Tons
Port Capacity Range
1.0
0
Total Throughput Tonnage
Baseline Tonnage
1980
1990
2000
2010
2020
2030
LIQUID BULK
Million Tons
1.0
0
1980
1990
2000
2010
2020
20

Figure 9

Whittier - Cargo Forecasts and Existing Capacity by Handling Category

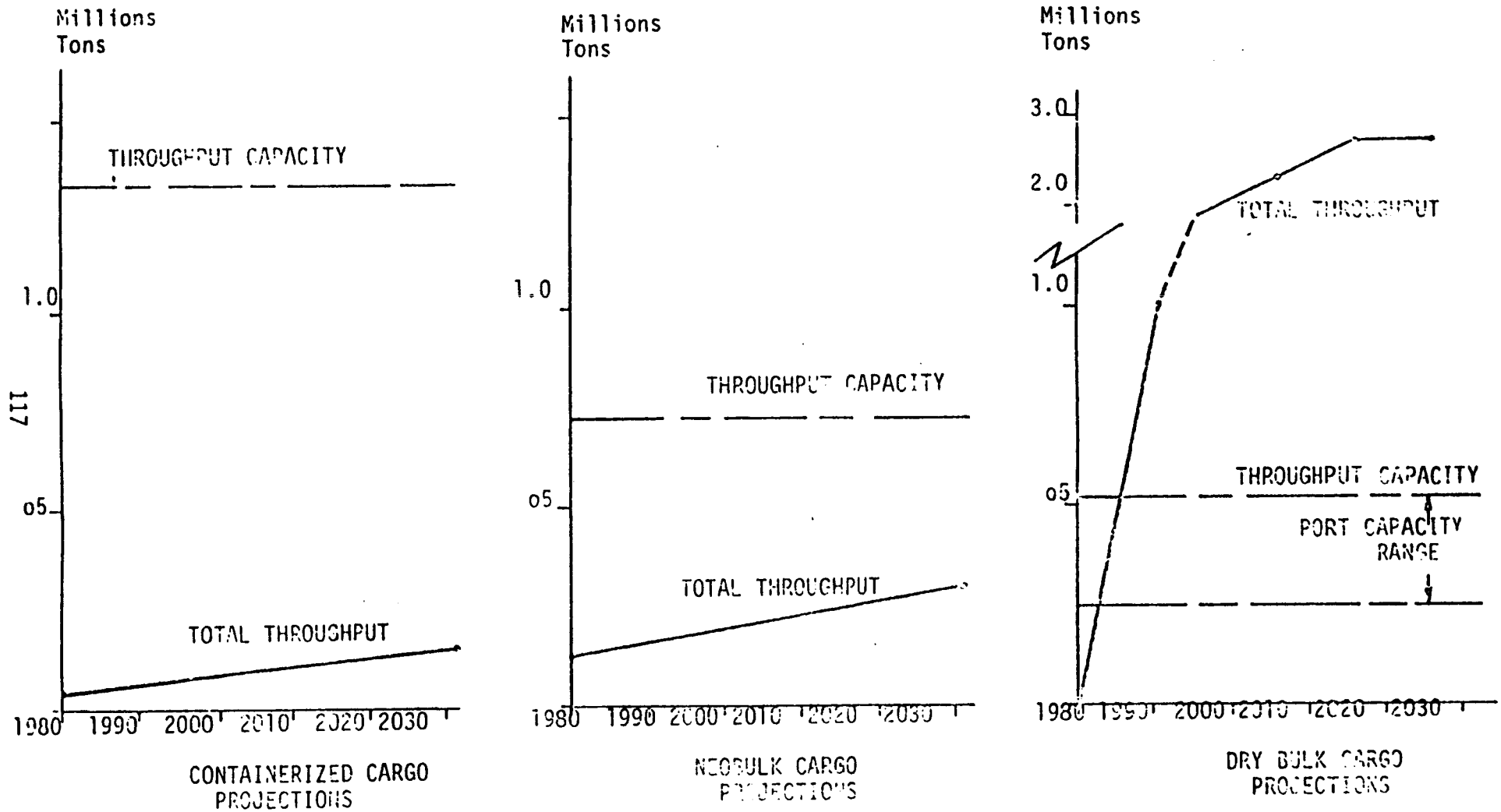


Source: Southcentral Deep-Draft Port Study, prepared by Alaska Consultants, Inc. and PRC Harris, Inc. for U.S. Corps of Engineers.

Figure 10

Seward - Cargo Forecasts and Existing Capacity by Handling Category

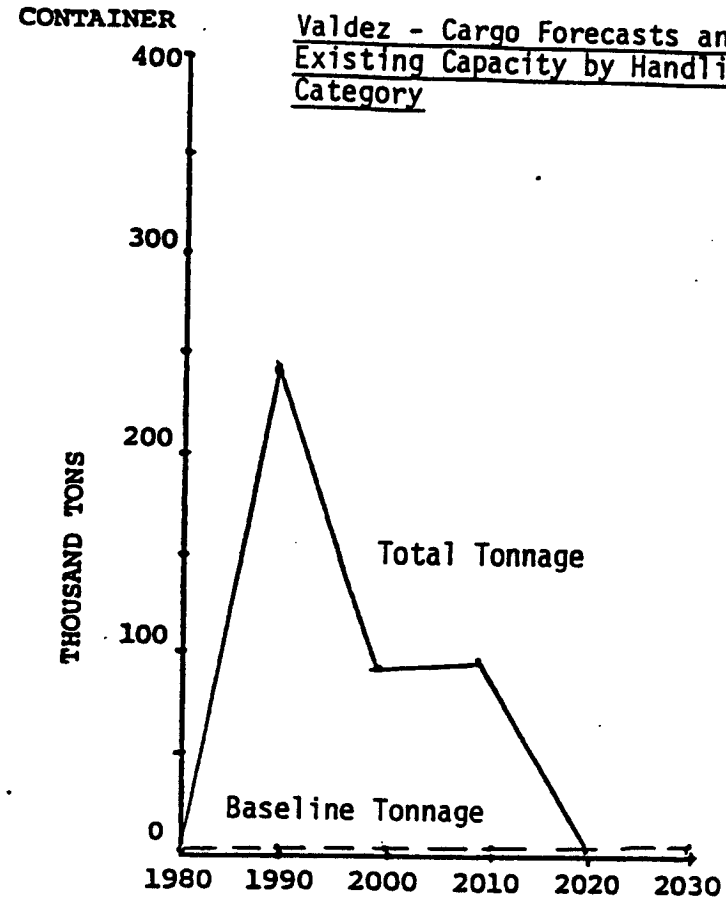
1980 to 2030

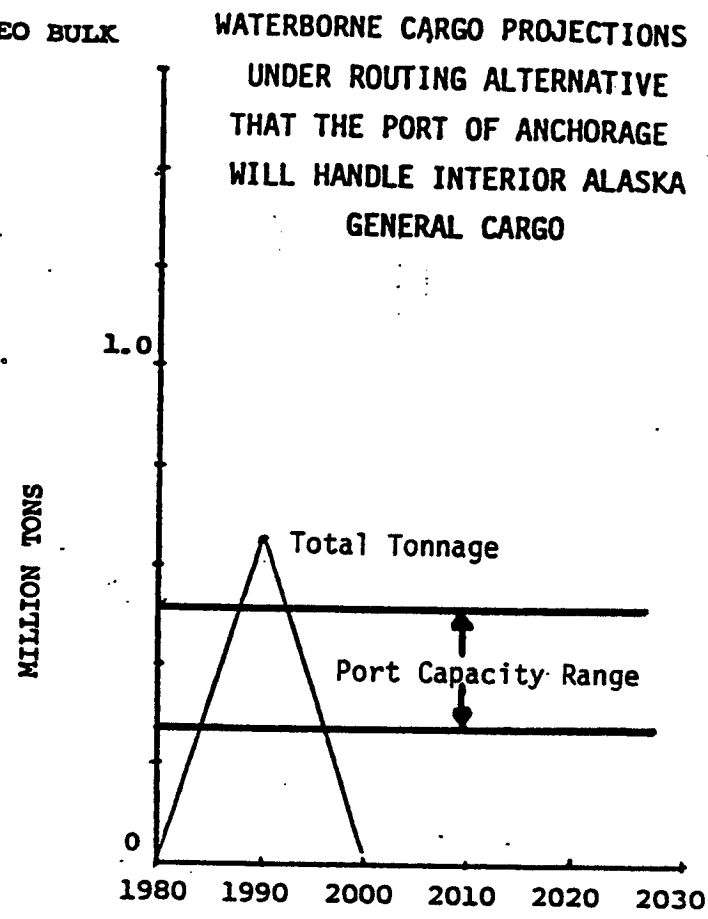


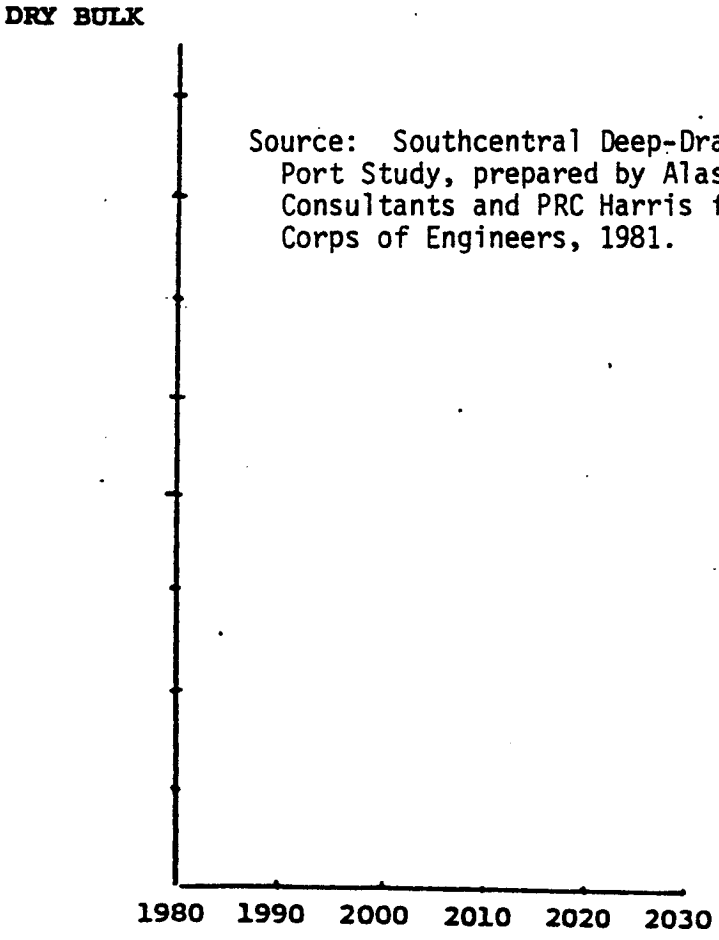
Source: Southcentral Deep-Draft Port Study, prepared by Alaska Consultants, Inc. and PRC Harris, Inc. for U.S. Corps of Engineers. 1981.

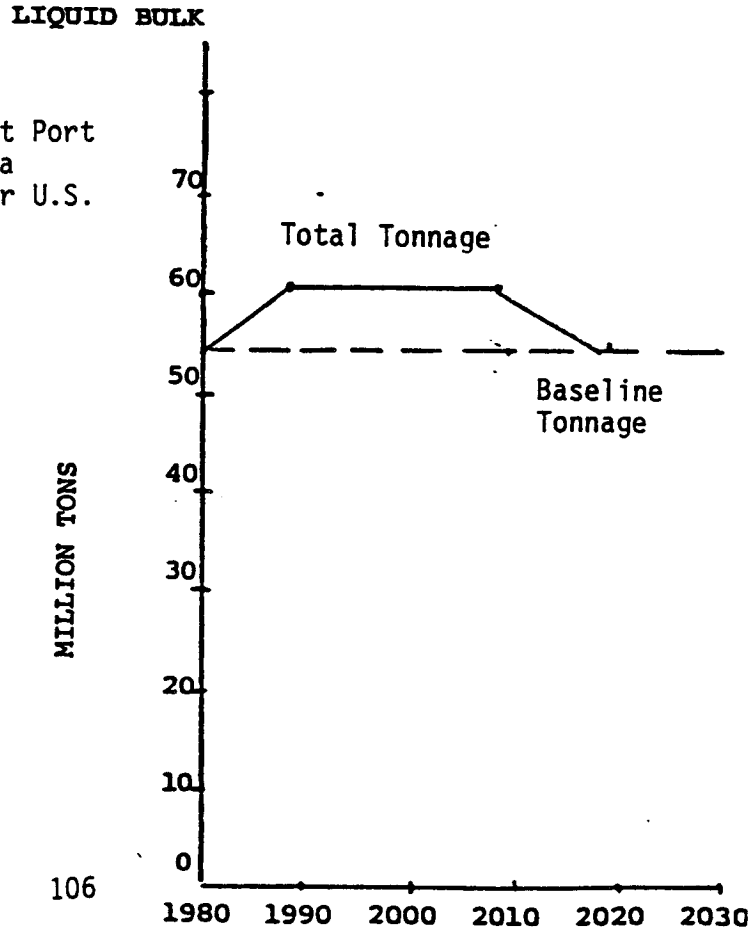
Figure 11

Valdez - Cargo Forecasts and Existing Capacity by Handling Category









Source: Southcentral Deep-Draft Port Port Study, prepared by Alaska Consultants and PRC Harris for U.S. Corps of Engineers, 1981.

between the two scenarios for the year 2000 is substantial.

Valdez's ability to attract fifty percent of Fairbanks containerized traffic appears to be overly optimistic. Such a condition assumes an equal attraction to Anchorage and Valdez by large shippers. Although the road mileages to Fairbanks from Valdez and Anchorage are virtually the same, Anchorage will continue to maintain a much higher level of marine service and also offers excellent intermodal transfers to air and rail transportation. This analysis assumes that all containerized freight to Fairbanks will continue to pass through the Port of Anchorage.

Population-related (baseline) tonnage for the Port of Anchorage will continue to dominate inbound freight movements. Only Prudhoe Bay development and the Alaska gas pipeline project are expected to produce substantial tonnage unrelated to population. Based on 1990 forecasts, these two projects will produce approximately 20 percent of all inbound dry cargo (containerized, neobulk, and breakbulk). Except for neobulk/breakbulk cargo, tonnage for each category for a given period is greater than for the preceding period. Containerized tonnage, which was 75 percent of the inbound tonnage in 1980, is forecast to increase 121 percent to 1.8 million tons (1.63 million metric tns) by the year 2000. The imbalance between inbound and outbound cargo is expected not only to continue but become more pronounced.

Anchorage originally had been selected as the location for the export of Healy coal to South Korea, but major expenditures would have been necessary to correct poor soil conditions. Anchorage decided to eliminate itself as a contender. It apparently will continue to

specialize in containerized freight.

Whitter is not expected to benefit substantially from development activities taking place during the remainder of this century, according to the Corps of Engineers report. Steady growth in baseline demands are expected to occur for all inbound freight categories except liquid bulk. Outbound freight is expected to remain at present levels. Dry goods are forecast to show a 159 percent increase from 1980 to 2000.

The Corps of Engineers Study assumed that Seward would become the major Southcentral port for the export of bulk shipments, such as coal and mineral ores. Coal exports are forecast at 1.0 million tons (907,180 metric tons) by 1990 and 1.6 million tons (1.45 million metric tons) by 2000.

The City of Seward has embarked on an ambitious, long-range effort to develop its Fourth of July Creek across Resurrecton Bay from the town as an industrial complex. A 2-1/2 mile (4 km) access road has been provided by the Alaska legislature, and the city has committed $2 million to private and public infrastructure at the site. The Port of Seward has more available land for the storage of bulk materials. Additonal facilities would have to be developed between 1990 and 2000, and the decision could be made to place them at Fourth of July Creek.

Seward is expected to have increases in both containerized and neobulk cargo. By 2000, tonnages for the two categories together will still be less than 90 thousand tons (81.6 thousand tons).

The Port of Valdez handled only 4,400 tons (3,991 metric tons) of dry goods in 1980. Unless the port can attract a significant

percentage of freight destined for the Interior from what is now going through Achorage, by 2000 the baseline tonnage will still be less than 10,000 tons (9,0718 metric tons). The port had been expected to handle major tonnages for the Alpetco project, but it has been cancelled.

4.4.1.1.2. Impacts

Based on the information in Tables 8-11, only three situations are forecast before 2000 where capacity problems at Southcentral ports would exist. Only one of them is affected by activities on the North Slope. The Port of Anchorage is expected to reach the low capacity threshold for containerized cargo early in the 1990's. The existing port of Seward will exceed its capacity for dry bulk cargo soon after it begins coal shipments. It is likely that a major dry bulk facility eventually will be constructred in the Fourth of July Creek area. The final location with potential capacity problems is the TAPS marine terminal at Valdez. Should oil shipments closely approach TAPS' ultimate capacity of 2.0 million barrels per day, a fifth teminal, for which preliminary planning has already been done, would have to be constructed.

A slight impact related to marine carriers can be expected. Crowley Maritime operates the Arctic sealift as well as the Hydro-train service between Seattle and Whittier. In 1981, it reassigned several of the Hydro-train barges to the sealift. This practice could create short-term capacity problems during summer months when the demand is highest if TOTE, Sealand, and Canadian

National (the other rail-barge carrier operating to Whittier) are unable to handle all diverted traffic. Otherwise, major carriers can be expected to gradually increase the number of vessels serving Southcentral ports.

4.4.1.2. Arctic Sealift

4.4.1.2.1. Demand

The sealift will be required at Prudhoe Bay as long as development activities are in progress at road-connected fields and heavy modules are required. For other fields, the marine mode will play a more substantial role throughout the life of the project because a land mode will not be available on a year-round basis. Much of the freight could arrive at Prudhoe Bay by land and then be transshipped. The 1981 sealift carried 91 modules on 14 barges. The largest of the modules weighed over 2,000 tons. The sealift will remain a vital element of the overall transportation system for North Slope oil and gas activities during the 1980's. Peak demands can be expected in the next three to four years as continuing development of Prudhoe Bay fields coincides with development of onshore fields to the east and facility needs related to the gas pipeline. The sealift is not expected to carry any materials for the pipeline project except for building and equipment modules, but they are substantial. Over 200 modules alone will be required for the gas conitioning plant. And the waterflood project in 1983 requires 43 modules. Sealift operations during the summer to some extent could conflict with gravel loading operations associated with construction of artificial islands.

4.4.1.2.2 Impacts

A discussion of the impacts of increased sealift traffic on facilities at Prudhoe Bay must first emphasize that all facilities are privately owned and do not serve any freight for public consumption. Subject to restraints imposed by the permitting process, the companies are able to make long-range plans and carry out projects they feel are justified. By the time that the first modules arrive for the waterflood project in 1983, northwest dock (DH 3) will have been enlarged and the causeway widened to accomodate two module carriers. No additional causeway construction at Prudhoe Bay is anticipated.

However, the unllading facilities are limited taking into account the short shipping season and the large shipments planned for the mid 1980's. Priorities will have to be established, and it might be necessary for shippers to make ue alternative loading locations if possible.

4.4.1.3. Barrow and Camp Lonely Marine Traffic

Traditionally, Barrow has been served by only the North Star III, operated by the Bureau of Indian Affairs, and the COOL Barge, which provides service to Federal installations. Due to the availability of commercial shipping to Barrow, it is possible that the BIA will no longer provide service to Barrow. At present, it is the easternmost community on the North Slope served by the North Star III.

The role of Barrow in the exploration and development of NPR-A is

uncertain, but marine freight to the area can be expected to continue at relatively high volumes. Between 1977 and 1981, approxiately 108,000 tons (98,000 metric tons) of bulk fuel and dry cargo were unloaded at Lonely and Barrow to support NPR-A drilling operations. No vessel unloading facilities for the community are anticipated to be constructed.

4.4.1.4. Mackenzie River

NTCL is expected to continue to serve its traditional role of transporting freight to villages in the Northwest Territories but also to support oil and gas activities in the Canadian Beaufort Sea and to a lesser extent for activities in the Alaskan Beaufort Sea. The demands of supporting oil and gas activities have not affected its ability to deliver freight to Northwest Territory villages. As demands for logistical support of oil and gas activitites increase, several private Canadian companies are expected to seriously compete with NTCL for traffic. Conceivably, these companies might also try to compete for traffic to Alaskan Beaufort Sea destinations.

Utilization of the Mackenzie River route, unless conditions on the Haul Road continue to deteriorate, will remain at a low level. As shown in Table 25, the largest number of barge loads will occur in the period 1982-1984. This route has the capability of increasing its traffic level substantially, but long-range plannng is required since the shipping season is not much longer than that of the sealift.

Table 25

Transportation Forecasts for Drilling and AHGPS Supplies

Year	Drilling Tonnage	Mackenzie River Barge Loads(1)	Natural Gas Pipeline Tonnage(2)	Haul Road Truck Loads(3)
1981	61	6		4351
1982	135	13		9615
1983	125	13	170	24129
1984	146	15	170	25602
1985	83	8	170	21094
1986	73	7		5183
1987	73	7		5186
1988	72	7		5113
1989	54	5		3870
1990	43	4		3053
1991	22	2		1548
1992	19	2		1376
1993	12	1		860
1994	8	1		602
1995	8	1		602
1996	2	0		172
1997	0	0		0
1998	0	0		0
1999	0	0		0
2000	0	0		0

Note: (1) MacKenzie River barge load figures assume ten percent drilling tonnage will go by this route and average loads of 1,000 tons per barge.

(2) Natural gas pipeline tonnage considers only estimates of pipe and fuel to be used north of Fairbanks.

(3) Haul Road Truck Loads is based on following assumption: 80 percent of drilling tonnage and 100 percent of gas pipeline tonnage will go north from Fairbanks by truck, truck capacity of 28 tons, and a factor of 2.5 to account for smaller then capacity loads and shipment of miscellaneous freight.

Source: Peter Eakland and Associates, 1981.

4.4.1.5. Oil and Gas Transportation

No oil or gas has yet been delivered from the Arctic to southern destinations by tankers. The date when ths event will actually occur is still uncertain but most likely will occur during this decade. The first shipments will be Canadian oil, and it is expected that Alaskan fields that will be explored and developed during this decade will use TAPS.

Roger Herrera, in a recent speech, summarized the current feelings about tankers versus use of the existing pipeline for the transportation of oil from Alaska's Arctic regions as follows:

> It is very difficult to foresee the potential throughput of the TAPS pipeline - two million barrels of oil per day - being exceeded before the year 2000. If in fact that opinion happily proves to be wrong and there is a shortage of transportation capacity from the Arctic sometime in the future, the alternative of tanker transportation will undoubtedly be considered. The February 1981 voyage of the Coast Guard ice breaker, the Polar Sea, to Pt. Barrow clearly showed the shortcomings of winter ship movement through the arctic pack. But on the other hand, the remarkable and innovative Canmar icebreaker, the Kigoriak, which has been operating in the Canadian Beaufort for the past two years has made possible the design and development of Dome Petroleum Company's Class 10 icebreaker tanker concepts which will

probably be constructed and carrying oil to the East coast via the Northwest Passage on a routine basis in 10 years time. However, the relatively shallow water, extreme ice conditions within the Arctic gyre, and political and environmental considerations in the Alaskan Beaufort will probably mandate that further oil movements continue to be via pipeline to Valdez. Any gas production will also be carried by a pipeline system rather than by icebreaking LNG carriers. But such ships have been proposed in Canada by the Arctic Pilot Project to carry gas from Melville Island to the East Coast markets. The influence of the Canadian Arctic transportation schemes - if they work and are economic - should not be underestimated in Alaska. I think we will gain measurably by the Canadian experience but probably by upgrading safety of tanker movements in the ice environments of the Bering Sea region rather than in the Chukchi or Beaufort Seas.

4.4.1.6. Institutions

The Coast Guard odes not have stationed in Alaska a heavy-duty icebreaker. The Seventeenth Coast Guard District has expressed an interest in obtaining a shallow-draft icebreaker that it could use in the Bering Sea and even further north. The decision has been made to re-engine and refurbish the Storis, a medium-endurance cutter with increased ice-breaking capabilities, to help meet short-range needs. The vessel is stationed at Kodiak.

The Coast Guard does not have the authority to support commercial

shipping operations except in the Great Lakes. Icebreakers in Alaska are used only for scientific and search and rescue missions. President Ford in 1975 declared an emergency situation when the Arctic sealift became ice-bound, and the Coast Guard was then able to provide assistance to the vessels in reaching their destination.

No vessel traffic problems are anticipated at any points in the likely routes of tankers or tugs and barges between the North Slope and west coast ports except at Unimak Pass, which is also heavily used by fishing vessels. A fairway four miles wide, which would reduce the potential for collisions or interference with fishing operations, has been proposed but not implemented.

4.4.2. LAND MODES

4.4.2.1. Roads

4.4.2.1.1. Demands

Table 26 shows the estimates for one-way truck trips north of Fairbanks due to North Slope drilling activities and movement of pipe and fuel for construction of AHGPS. A factor of 2.5 has been used to account for trips unrelated to drilling supplies and for trips operated at less than capacity (28 tons, or 25.4 metric tons). Over 20,000 one-way trips are forecast for the years during which the gas pipeline is scheduled to be constructed.

The Alaska Department of Transportation and Public Facilities has forecast traffic for the Haul Road after the completion of the gas

pipeline which would give it a starting date of 1986 (Table 26). Total annual one-way trips are forecast at 23,750, which translates into an average annual daily traffic (AADT) of 130 vehicles. The forecast does not consider the effect of drilling activities in non-Prudoe Bay fields that will be under development after that date. Assuming that the figures in Tables 25 and 26 are additive, the AADT in 1984 woul be 270 vehicles per day. This figure exceeds the highest AADT recorded to date on the Haul Road during a full year of operation. The highest AADT figure to date was 231 vehicles per day in 1977.

DOTPF estimated that approximately 20 percent of the traffic on the Haul Road after gas line construction would be private vehicles. Governor Jay Hammond in 1978 established an interim policy that would prohibit private vehicles from using the road until after pipeline construciton. The road, however, was first opened to the public in June, 1981.

4.4.2.1.2. Impacts

Major increases in truck traffic on the Haul Road are expected over the next three years. Unfortunately, the condition of the road has steadily deteriorated and emergency repairs had to be made when truckers boycotted the route in August, 1981 (Anchorage Daily News, 1981e). Truckers at that time itemized 38 specific safety hazards. Speeds in some cases had to be reduced to two miles per hours, and average travel time had increased to 18 hours from 10 hours when the

Table 26

Traffic Projections - Haul Road:

* Projected Yearly Traffic Volumes

	Light Vehicles	Common Carriers
Gasline Operator	3,000	4,550
Alyeska	5,850	9,150
Prudhoe Bay Operators	4,500	6,975
State and Federal	3,150	1,075
Private	9,000	250
Total Yearly Two-Way Traffic	25,500	22,000
Total Round Trip Traffic	12,750	11,000

Source: DOT/PF Interior Region Planning, based on data gathered between August 1977 and September 1979.

*This table represents the anticipated traffic volumes on the Haul Road after gasline construction is complete and the traffic has stabilized.

Source: Major Project Review: Policy Analysis for Utilization of the North Slope Haul Road, prepared by Alaska Department of Transportation and Public Facilities, 1980.

road first opened.

The extent of improvements needed to bring the Haul Road's condition up to acceptable standards now approaches reconstruction, and such improvements cannot be accomplished in one construction season. Inevitably, the road will still be substandard in some respects in 1983 which is forecast to have the peak demand during the study period.

Difficulties will likely occur in performing reconstruction work at the same time that gas line constructon is underway. Before reconstruction is completed, DOTPF will have to expend considerable maintenance funds to maintain the status quo. Continuing damage to equipment and low average speeds will result in cost increases to shippers. However, alternate surface routes, namely the sealift and the Mackenie River, likely will not greatly increase their percentage of traffic. At present, these routes are competitive price-wise but have less flexibility and their use results in higher inventory costs. Should the road be closed for any considerable length of time, slight delays in all projects on the North Slope could result, with the exception of those in NPR-A which will not rely on the Haul Road for logistics support. Oil companies generally have contingency plans. They would be reluctant to incur the high costs of air freighting drilling supplies to Prudhoe Bay, but the costs of delay for some projects could be even higher.

4.4.2.2. Railroad

4.4.2.2.1. Demands

The Alaska Railroad experienced net losses from 1977 to 1979. Because of the State's sparse population and lack of manufacturing, the railroad has had to rely on a small number of commodity groups. In coming years, it will continue to be vulnerable to changes in these markets. In 1977, three commodities made up 80 percent of the railroad's total revenue tons. Each had at least 20 percent of the tonnage. By 1980, sand and gravel had increased its traffic share to 35.2 percent, and coal to 29 percent. On the other hand, the third commodity group, petroleum products, had dropped 43 percent to 12.1 percent due to a slow down in development activities and completion of the North Pole refinery.

Freight traffic growth is forecast to be less for intrastate freight movements (1.94 percent average annual increase) than for shipments entering the State (2.89 percent) (Gray, 1978). This is due to the coastal location of most of the State's population and of fishing and timber resource activities.

Railroad tonnage between Anchorage and Fairbanks in 1977 was 728,000 tons (660,427 metric tons), which was approximately 80 percent of the surface freight shipments between the two cities. The railroad is expected to maintain its dominant position in this market. Forecast Anchorage - Fairbanks tonnages in 1992 for a moderate growth scenario are 1,012,000 tons (918,000 metric tons), which for the

fifteen year period produces an average annual growth rate of 2.2 percent. Such growth will not eliminate the financial problems facing the railroad. The Alaska Statewide Rail Systems Study, prepared in 1981 by Bivens and Associates, Inc., concluded that the existing traffic base is inadequate to maintain the size of the ARR system in first-class and efficient condition.

The study offers the following long-range advice:

> Any future planning for the Alaska Railroad must give serious consideration to what balance is desired between such ingredient influencig factors as levels of traffic; revenues from the traffic; the size, condition and efficiency of the physical plant; and the amount (perhaps over and above "ordinary" levels) desired to be spent on maintaining the plant (p. III-6.5).

Despite a less than optimistic long-range future, the ARR should be able to operate in the black during most of the 1980's. At least 50,000 tons (45,359 metric tons) of drilling supplies are forecast from 1981 to 1989. Of the 1.5 million tons (1.36 million metric tons) of freight related to gas line construction forecast for intrastate movement, a high percentage will travel on the ARR. During 1983 alone, pipe movements to Fairbanks for the project are estimated at 600,000 tons (544,308 metric tons). During that year, drilling tonnage for North Slope activities forecast to be carried on the Haul Road will add an additional 125,000 tons. Shipments of coal may help provide the long-range stability that the ARR needs. Shipments of Healy coal to Seward are forecast to be one million tons (907,180

metric tons) by 1985 and two million tons (1.8 million metric tons) by 2000 (Alaska Consultants, Inc. and PRC Harris, Inc., 1981).

4.4.2.2.2 Impacts

The railroad should have no problems carrying forecast increases in traffic related to development projects in the Interior with careful scheduling of trains and the use of longer trains. The pipe for the gas line probably would arrive either in Anchorage or Seward by pipe ships. The availability of rail barges could be a constraint for interstate traffic if the pipes are shipped to Alaska by that mode. The most likely transportation constraint probably would be availability of rail cars. In its submission to the Federal Energy Regulatory Commission, Alaska Northwest Natural Gas Transportation Company said that additional rail cars could be brought to Alaska from the Lower 48 as needed.

The Federal government in 1981 announced its intention to relinquish ownership of the ARR, and the State is seriously considering taking title. Negotiations with Congress are expected to be difficult, due to uncertainties about land ownership, about the ability of the State to extend the railroad, and about pension liabilities. Uncertainties exist concering the organizational structre under which the railroad would operate if acquired by the State. An independent agency free from political pressures would likely operate the railroad, but the State would consider proposals for private enterprise to operate it.

Although some deferred maintenance has taken place, upgrading of

the roadbed and equipment in recent years places the railroad in a good position to efficiently handle increased traffic levels. In 1979, maintenance costs amounted to 29.1 percent of operating expenses, which is considerably greater than the nation-wide average for comparable railroads.

4.4.2.3. Pipelines

Table 27 summarizes the moderate (50 percent likelihood) scenarios for North Slope oil fields. Production never exceeds the ultimate design capacity of TAPS (2.0 million barrels per day) and is expected to peak at 1.9 million barrels per day in 1987. The peak remains the same whether or not production from NPR-A on the first Beaufort Sea Sale (1979) is considered since initial production from these areas occurs after 1987. Assuming that the total production will be transported by TAPS, Figure 12 shows a plot of annual production compared to existing TAPS capacity of 1.6 million barrels per day.

4.4.2.3.2. Impacts

The peak oil production that is forecast for the moderate development scenario can be handled by the existing pipeline system without looping. Whether or not a fifth terminal is required for tankers at Valdez will depend upon the size of tankers that are used in coming years and what is considered an acceptable waiting period.

Table 27

Daily Oil Production on North Slope from
Proven and Hypothetical Reservoirs (1)

(Thousands of Barrels per Day)

Year	Prudhoe Bay	Kuparuk River	Lisbourne Pt. Thompson	NPR-A	1979 Beaufort Sea Sale	Other Onshore (2)	Total (3)
1981	1,500	0	0	0	0	0	1,500
1982	1,500	60	0	0	0	0	1,539
1983	1,480	80	50	0	0	0	1,558
1984	1,480	100	100	0	0	0	1,690
1985	1,490	100	200	0	0	0	1,771
1986	1,540	100	200	0	0	50	1,808
1987	1,540	100	200	0	0	50	1,906
1988	1,370	100	200	66	0	50	1,745
1989	1,050	100	200	132	0	50	1,465
1990	800	90	200	132	0	50	1,377
1991	765	81	180	132	4	100	1,295
1992	570	73	162	132	113	100	1,289
1993	450	66	146	132	148	100	1,279
1994	370	59	131	132	151	100	1,185
1995	310	53	118	132	151	100	1,112
1996	250	48	106	119	151	100	1,094
1997	200	43	96	107	148	100	1,013
1998	160	39	86	96	145	100	935
1999	130	35	77	87	142	100	867
2000	100	31	70	78	132	100	791

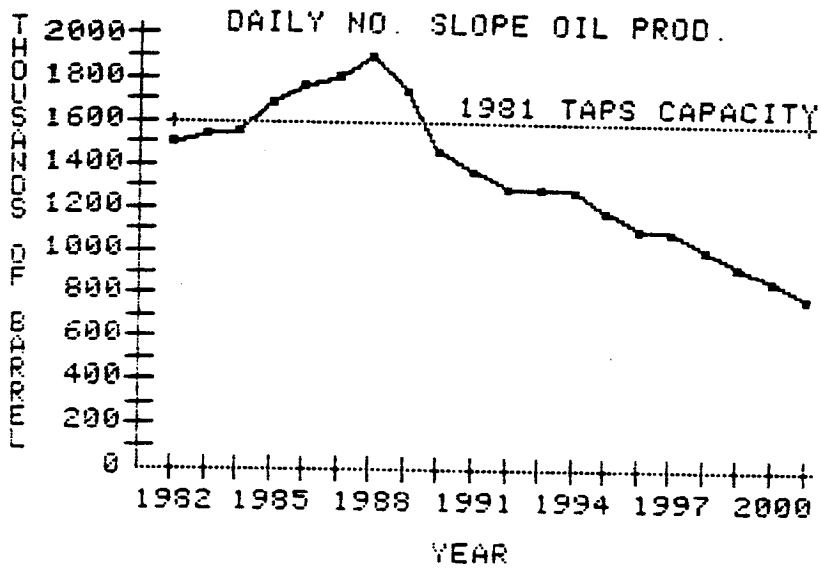
Notes: (1) Figures are based on 50 percent scenarios for all fields mentioned.

(2) Does not include Arctic National Wildlife Refuge.

(3) Statistical methods used to develop this table do not necessarily produce totals that are the sum of figures for individual fields.

Source: A. Tussing, "The Outlook for Alaska North Slope Crude Oil Production," Institute of Social and Economic Research, University of Alaska. Research Summary No. 8, January, 1981. p.4.

Figure 12



Source: A. Tussing, "The Outlook for Alaska North Slope Crude Oil Production," Institute of Social and Economic Research, University of Alaska. Research Summary No. 8, January, 1981. p. 4.

4.4.4 AIR MODE

4.4.3.1. Anchorage and Fairbanks

Existing runway capacities are forecast to be adequate throughout the study period at Anchorage and Fairbanks, according to master plans prepared recently by the Alaska Department of Transportation and Public Facilities. Major terminal improvements are under construction at Anchorage International Airport and are programmed for construction at Fairbanks International Airport.

Most workers on development projects on the North Slope will pass through one or both of the two airports. An employee, for example, who works on the North Slope for two weeks followed by two weeks off would pass through the Anchorage airport 26 times a year. Demands generated by passenger travel are greater on passenger terminals than on landing facilities. One medium-body jet carries as many as 130 persons. On many trips, a passenger may have to change planes at an intermediate point, and, thus, utilizes the terminal twice. For Anchorage, air passenger traffic related to development activities in the State are overshadowed by other trips handled by the facility. This fact has been documented in previous transportation impact reports prepared as part of the Outer Continental Shelf Socioeconomic Studies program (Peter Eaklnd and Associates, 1980).

Direct flights between the North Slope and Anchorage help reduce demands on Fairbanks facilities. The flights carry freight as well as passengers.

The level of air freight demands will remain at present levels to

support drilling activities unconnected by road to Prudhoe Bay. These operations will occurr predominately during the winter when ice runways can be used. Year-round gravel strips generally will be built once the development phase begins, alhtough they are also occasionally constructed when deep exploration wells are drilled. The air mode is important to Prudhoe Bay operators principally for transporting high-value, low weight freight and for passenger movements.

4.4.3.2. North Slope

Existing air facilities at Prudhoe Bay will be adequate throughout the study period. Deadhorse, the major facility, is owned and operated by the State of Alaska, which is in the process of preparing a land use master plan for the facility. Development of a master plan is also underway for the Barrow airport. Alaska Airlines has announced plans to provide scheduled service to Deadhorse from both Anchorage and Fairbanks.

Table 28 shows forecasts for air passengers, mail, and freight at Barrow. Tourism is expected to dramatically increase by 1985 compared to 1978 levels. Inbound air mail and air freight at Barrow, respectively, are forercast to be 2,330 and 2,950 tons (2,114 and 2,676 metric tons) by 1985.

Flights into Barrow can be expected to increase because of the closing of the airfield at the Naval Arctic Research Laboratory, the leasing of tracts in NPR-A for exploration, and increases in tourism.

Table 28

Air Passenger and Freight Forecasts[1]

Passengers (One-Way Trips)	1978	1985	1990	1995	2000
1. Within the North Slope Region	11,000	12,400	14,700	16,000	17,800
2. Between the North Slope and Nana Regions	5,300	6,000	7,300	8,600	8,100
3. Between the North Slope and External Regions					
Barrow Tourists	8,000	20,500	23,800	28,500	35,300
Other Trips	33,500	35,500	40,100	43,100	22,900
Air Mail (Tons) - By Destination					
Barrow		2,330	2,626	2,993	3,401
Villages		754	749	825	900
Air Freight (Tons) - By Destination					
Barrow		2,950	3,338	3,745	4,212
Villages		2,170	2,170	2,400	2,503

Note: (1) Excluded are passenger and freight traffic generated by oil and gas exploration and development activities.

(2) Average of upper and lower bound interim forecasts used.

Source: Louis Berger and Associates. Western and Arctic Alaska Transportation Study. Phase 2 draft report.

4.4.4. SUMMARY OF IMPACTS

Impacts due to transportation demands of baseline conditions from 1981 to 2000 are likely to occur in both the marine and land modes. No impacts for the air mode are foreseen given the implementation of capital improvement projects either underway or already programmed.

For the marine mode, large shipments of modules to Prudhoe Bay will take place in the early and mid-1980's as part of nearby development activities. Impacts of population growth on marine systems are expected only at the Port of Anchorage where an additional berth would apparently be justified early in the 1990's. Seasonal capacity problems might exist on the Hydro-train service if barges are shifted to the sealift during the summer.

Impacts on land transportation systems are related to the poor condition of the Haul Road. This siutaiton coincides with the onset of major development activities (Waterflood Project and Kuparuk Field Development) at or near Prudhoe Bay and possibly construction of the gas pipeline. Alternative transportation routes, exist, but they are either considerably more expensive (air freight) or are only available during the summer (Arctic sealift and Mackenzie River). Once the road and bridges on the Haul Road are improved to Federal Secondary Road System standards and thereafter adequately maintained, impacts of truck traffic should be minimal since the vehicle capacity for the road has not and should not be a problem for the foeseeable future in good weather.

REFERENCES

Alaska Construction and Oil. 1980. Prudhoe waterflood project. June: 25-30.

Alaska Consultants, Inc. and PRC Harris, Inc. 1981. Southcentral region of Alaska deep-draft navigation study. Draft report. Prepared for the U.S. Army Corps of Engineers, Alaska district. Anchorage.

Alaska Department of Highways. 1975. Federal-aid highway system annual traffic volume report. 276 pp.

Alaska Department of Transportation and Public Facilities. 1981. Anchorage international airport master plan.

Alaska Department of Transportation and Public Facilities, Transportation Planning Division. 1977-1980. Alaska highway annual traffic volume report, 1976-1979. Reports issued annually.

Alaska Department of Transportation and Public Facilities. 1980a. A performance evaluation of paved roadways on the Alaska state highway system. Working paper. 42 pp.

Alaska Department of Transportation and Public Facilities. 1980b. Paved highway performance evaluation. In-house computer printout. 125 pp.

Alaska Department of Transportation and Public Facilities, Division of Planning and Research. 1980c. Major project review: policy analysis for utilization of the North Slope haul road. 71 pp.

Alaska Department of Transportation and Public Facilities. 1979. Anchorage international airport master plan program summary. 23 pp.

Alaska Department of Transportation and Public Facilities. 1978. Anchorage international airport terminal expansion recommendations. 34 pp.

Alaska Industry. 1981. Alaska airlines building a terminal at Prudhoe Bay. September.

Alaska Journal of Commerce & Pacific Rim reporter. 1981. Marine park looks good. October 12.

Alaska Journal of Commerce & Pacific Rim Reporter. 1980. Air, marine dominate transportation. August 11.

Alaska Northwest Natural Gas Transportation Co. 1980a. Certification cost and schedule estimate. Vol. II. Docket No. CP80 before the Federal Energy Regulatory Commission.

Alaska Northwest Natural Gas Transportation Co. 1980b. Construction and logistics plan WP-4. Work papers in support of Exhibit K. Vol.

X. Docket No. CP80 before the Federal Energy Regulatory Commission.

Alaska Northwest Publishing Co. 1981. The milepost. Anchorage. 498 pp.

Alaska Transportation Commission. 1981. Air carrier operating authority, scope book directory.

American Association of State Highway Officials. 1967. A policy on geometric design of rural highways, 1965 edition. Washington, D.C. 650 pp.

American Petroleum Institute. 1971. Primer of oil and gas production. Dallas, Texas. 81 pp.

Amos, H., Operations, Northern Transportation Co., Ltd. 1981. Personal communication.

Arctic Environmental Engineers. 1979. Feasibility study for industrial development at Fourth of July Creek, Seward, Alaska. Preliminary report. Prepared for the City of Seward.

Associated Press. 1981a. House OK's haul road resurfacing. Anchorage, Times. April 8.

Associated Press. 1981b. North slope cargo sealift is prepared. May 15.

Associated Press. 1981c. Truckers to boycott risky highway. Anchorage Daily News. August 8.

Berger, Justice T.R. 1977. Northern frontier, northern homeland. James Lorimer & co., Toronto, Ontario. Vol. 1: the report of the Mackenzie Valley pipeline inquiry. 209 pp. Vol. 2: terms and conditions. 268 pp.

Bivens & Assoc., Inc. 1980. Alaska statewide rail systems study. Prepared for the Alaska Department of Transportation and Public Facilities.

Bregha, F. 1979. Petroleum development in northern Alaska. Proceedings of symposium on marine transportation and high arctic development: policy framework and priorites. March 21-23. Montebello, Quebec. pp. 223-251.

Brovald, K., SOHIO-BP transportation offcer. 1981. Personal communication.

Business Week. 1981. A cheaper route for Alaskan oil. March 9: 27-28.

CCC/HOK. 1978. Prudhoe Bay case study. Prepared for socio-economic studies program, Alaska outer continental shelf office, Bureau of Land Management. Anchorage. Technical report no. 4. 98 pp.

Corps of Engineers, Alaska District. 1980. Prudhoe Bay waterflood project final environmental impact statement. 3 vols.

Dennis Dooley and Associates. 1978. Beaufort Sea petroleum development scenarios: transportation impacts. Prepared for Peat, Marwick, Mitchell & co. as part of the socioeconomic studies program, Alaska outer continental shelf office, Bureau of Land Management. Technical memorandum no. 20. Anchorage. 163 pp.

Edmunds, T., ARCO transportation office. 1981. Personal communication.

Engineering Computer Optecnomics, Inc. 1977. Final report to the Federal-State Land Use Planning Commission for Alaskan on potential port site assessment. 37 pp. and appendices.

Environment Reporter. 1980. Coordinated federal approach needed towards marine affairs, speakers say. December 12: 1237-1238.

Fairbanks Daily News Miner. 1981. Gas conditionaing plant could be world's largest. September 22.

Federal Aviation Administration. 1980. Alaska Region Ten-Year Plan. FY1982-1991.

Federic Harris, Inc. 1979. Berth capacity methodology. Technical memorandum prepared as part of Phase I of Corps of Engineer's deep draft navigation study, southcentral region of Alaska. pages unnumbered.

Frederic R. Harris, Inc. 1978. Southcentral region of Alaska deep draft navigation. Stage I, economic and transportation studies. Phase I report (draft). Prepared for Alaska District, Corps of Engineers,
Department of the Army. 224 pp.

Gray, J.T. 1979. Transportation systems planning for Alaska. Prepared by Univ. of Alaska Institute of Social and Economic Research for Office of University Research, U.S. Department of Transportation. Anchorage. 150 pp. and appendices.

Harrison, G.R. 1979. The need for action-oriented R and D in the Canadian Arctic. Proceedings of symposium on marine transportation and high arctic development: policy framework and priorites. March 21-23. Montebello, Quebec. pp. 45-58.

Herrera, R. 1981. Untitled speech delivered on September 22 at Maritme Alaska '81 Conference. Anchorage. Proceedings to be published.

Highway Research Board, 1965. Highway capacity manual. Special report 87. National Academy of Sciences, Washington, D.C. 397 pp.

Hoos, R., environmental impact assessmnt ass't manager, Dome

Petroleum. 1981. Personal communication.

Knowlton, J. 1981. Tanker route study raises concerns. Anchorage Times. February 6.

Kossen, B. 1981. Kuparuk field first to be developed as oil work expands on North Slope. Anchorage Times. May 17.

Louis Berger & Assoc., Inc. 1980. Western and arctic Alaska transportation study. Phase I, Volume III: marine transportation. Draft report.

Louis Berger & Assoc., Inc. 1981. Western and arctic Alaska transportation study. Phase II draft report. Vol. II: chapters 3-5.

Marine Engineering/Log. 1980. Ninety ships to Dome fields. November: 108.

Matthews, S., Interior Region maintenance, Alaska Department of Transportation and Public Facilities. 1981 Personal communication.

Murphy, M.P. 1981. Coast Guard: arctic mission no failure. Anchorage Times. March 8.

O'Brien, P. 1981a. Kuparuk project on schedule. Anchorage Daily News. May 16.

O'Brien, P. 1981b. Advice for those driving the "Kamikaze Trail": take lots of money and spares. Anchorage Daily News. May 23.

Pernela, L.M. and staff. 1976. Census of Alaska transportation. Prepared for U.S. Department of Transportation. University of Alaska, Institute of Social and Economic Research. Fairbanks. 276 pp. and appendices.

Peter Eakland and Associates. 1980. Northern Gulf of Alaska petroleum development scenarios: transportation systems impacts. Prepared for Peat, Marwick, Mitchell & C. as part of the socioeconomic studies program, Alaska outer continental shelf office, Bureau of Land Management. Technical memorandum no. 31 310 pp. and appendix.

Petro Canada. 1980. Arctic pilot project. Calgary, Alberta. 6 p. brochure.

Pharand, D. 1980 Canada's jurisdiction over the northwest passage. Arctic Seas Bulletin. Vol. 2, no. 10. pp. 1-4.

Pratt, F. 1981. Huge Prudhoe sealift bringing job bonanza. Fairbanks Daily-News Miner. July 17.

Rafson, J., Interior Region Transportation Planning, Alaska Department of Transportation and Public Facilities. 1981. Personal communication.

Sims, W. 1981. Icebreaker nearing its icy goal. Anchorage Daily News. February 10.

Stout, J. NPR-A Alaska office. 1981. Personal communication.

Tetra Tech. 1980. North slope haul road - status of road conditions. Prepared for Atlantic Richfield Oil and Gas Co. Anchorage. 53 pp.

Tussing, A. 1981. The outlook for Alaska North Slope crude oil production: 1981 - 2000. Research summary no. 8, Institute of Social and Economic Research, University of Alaska. 8 pp.

U.S. Department of Commerce, U.S. Coast and Geodetic Survey. 1979. United States Coast Pilot 9. Pacific and arctic coasts - Alaska, Cape Spencer to Beaufort Sea. Ninth edition. Rockville, Md. 354 pp.

U.S. Department of the Interior. 1979. Final environmental impact statement, Beaufort Sea federal/state oil and gas lease sale. Prepared by Bureau of Land Management. Vol. 1 of 3. 397 pp.

U.S. Department of the Interior. 1980. Final report of the 105(b) economic and policy analysis. 116 pp. and appendices.

U.S. Department of the Interior. 1981a. The utility corridor land use decisions, Washington Creek to Sagwon Bluffs. Prepared by the Bureau of Land Management, Fairbanks district office. 58 pp.

U.S. Department of the Interior, Bureau of Land Management, NPR-A Alaska office. 1981b. National petroleum reserve in Alaska draft environmental assessment. 148 pp. and appendices.

U.S. Maritime Administration. 1980. Arctic marine transportation policy. Draft working paper. Prepared for ocean principals group. 9 pp.

Wall Street Journal. 1980. Dome petroleum plans $250 million outlay for shipyard. December 18.

Webb, J. 1980. Growth makes news on Mackenzie and offshore work cheers east. Northern development. Summer. p. 31.